ATA /Jefferson
Middle School Rebuild

Lane County School District No. 4J
C.I.P. # 410.436.003

Project Manual

Volume 2: Division 21 - 33

Bid Set
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SECTION 21 0000

FIRE SUPPRESSION BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work included in 21 00 00, Fire Suppression Basic Requirements applies to Division 21, Fire Suppression work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of fire protection systems for proposed project.

B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.

C. Definitions:
   1. Provide: To furnish and install, complete and ready for intended use.
   2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
   3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete Item of work furnished.
   4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent," substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted Item.
   5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.02 RELATED SECTIONS:

A. Content of Section applies to Division 21, Fire Suppression Contract Documents.

B. Related Work:
   1. Additional conditions apply to this Division including, but not limited to:
      a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. 01 33 00 Delegated Design Requirements: administrative and procedural requirements for Subcontractor Bidder-Engineered items.
      b. Drawings
      c. Addenda
      d. Owner/Architect Agreement
      e. Owner/Contractor Agreement
      f. Codes, Standards, Public Ordinances and Permits

1.03 REFERENCES AND STANDARDS

A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 21, Fire Suppression Sections and those listed in this Section.

B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
   1. State of Oregon:
      a. OAR Oregon Administrative Rules
      b. OESC Oregon Electrical Specialty Code
      c. OFC Oregon Fire Code
      d. OMSC Oregon Mechanical Specialty Code
      e. OPSC Oregon Plumbing Specialty Code

f. OSSC Oregon Structural Specialty Code
g. OEESC Oregon Energy Efficiency Specialty Code
h. Oregon Elevator Specialty Code

C. Reference standards and guidelines include but are not limited to the latest adopted editions from:
1. ABA Architectural Barriers Act
2. ADA Americans with Disabilities Act
3. AHRI Air-Conditioning Heating & Refrigeration Institute
4. ANSI American National Standards Institute
5. ASCE American Society of Civil Engineers
6. ASCE-7 ASCE-7 Minimum Design Loads for Buildings and Other Structures
7. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers
8. ASHRAE Guideline 0, the Commissioning Process
9. ASME American Society of Mechanical Engineers
10. ASPE American Society of Plumbing Engineers
11. ASSE American Society of Sanitary Engineering
12. ASTM ASTM International
13. AWWA American Water Works Association
14. CFR Code of Federal Regulations
15. CSA CSA International
16. EPA Environmental Protection Agency
17. ETL Electrical Testing Laboratories
18. FCC Federal Communications Commission
19. FDA Food & Drug Administration
20. FM FM Global
21. FM Global FM Global Approval Guide
22. IAPMO International Association of Plumbing and Mechanical Official
23. ICC International Code Council
24. IEC International Electrotechnical Commission
25. ICC-ESR International Code Council Evaluation Service Reports
26. HI Hydraulic Institute Standards
27. ISO International Organization for Standardization
28. LEED Leadership in Energy and Environmental Design
29. MSS Manufacturers Standardization Society
30. NEC National Electric Code
31. NEMA National Electrical Manufacturers Association
32. NFPA National Fire Protection Association:
    a. NFPA 13 Standard for the Installation of Sprinkler Systems
    b. NFPA 24 Standard for Installation of Private Fire Service Mains and Their Appurtenances
    c. NFPA 25 Standard for Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
    d. NFPA 72 National Fire Alarm and Signaling Code
33. NRCA National Roofing Contractors Association
34. NSF National Sanitation Foundation
35. OSHA Occupational Safety and Health Administration
36. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
37. TIMA Thermal Insulation Manufacturers Association
38. UL Underwriters Laboratories Inc.
39. USDA United States Department of Agriculture
40. USGBC United States Green Building Council

D. See Division 21, Fire Suppression individual Sections for additional references.

E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.

F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

G. Piping Insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.04 SUBMITTALS

A. See Division 01, General Requirements for Submittal Procedures and Section 01 3300 Delegated Design Requirements, as well as specific individual Division 21, Fire Suppression sections.

B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.

C. In addition:
   1. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
   2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.
   3. Submit shop drawings, calculations and product data sheets as one complete stand-alone package to AHJ, Owner's insurance underwriter and Engineer.
   4. Product Data: Provide Manufacturer's descriptive literature for products specified in Division 21, Fire Suppression Sections.
   5. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the Specifications and Drawings.
      a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed Item. Highlight connections by/to other trades.
      b. Include technical data, installation instructions and dimensioned drawings for products, equipment and devices installed, furnished or provided. Reference Division 21, Fire Suppression specification Sections for specific Item required in product data submittal outside of these requirements.
      c. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.
      d. For vibration isolation of equipment, list make and model selected with operating load and deflection. Indicate frame type where required. Submit manufacturer's product data.

e. See Division 21, Fire Suppression Sections for additional submittal requirements outside of these requirements.

6. Maximum of two reviews provided of complete submittal package. Arrange for additional reviews and/or early review of long-lead Item; Bear costs of additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
7. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Part 3 of this Section.
8. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 21, Fire Suppression coordination documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical and Division 28, Electronic Safety and Security submittals.
9. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
10. Substitutions and Variation from Basis of Design:
    a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
    b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.
11. Shop Drawings:
    a. Provide coordinated Shop Drawings which include physical characteristics of all systems, equipment and piping layout, pipe layout, hanger layout, sway brace layout, seismic restraints, sway brace calculations, drains, location of drain discharge, risers, valves, details, water test information, physical device layout plans, and control wiring diagrams. Reference individual Division 21, Fire Suppression Sections for additional requirements for shop drawings outside of these requirements.
    b. Shop Drawings and hydraulics calculations, sway brace calculations, trapeze hanger calculations, and the like, to be prepared under the direct supervision and control of a Professional Engineer competent to do such work and licensed in the state of Oregon. Drawings and calculations to bear the seal and wet signature of the professional Engineer.
    c. Provide Shop Drawings which indicate information required by NFPA 13. Include room names and fire sprinkler occupancy hazard classifications.
    d. Provide Shop Drawings illustrating information for Hydraulic Information Sign for each hydraulic remote area calculated.
    e. Utilizing the Reflected Ceiling backgrounds, provide Shop Drawings illustrating locations of fire sprinklers and piping.
    f. Utilizing the Structural backgrounds, provide Shop Drawings illustrating locations and types of hangers and sway braces.

g. Provide Shop Drawings illustrating each type of hanger, including fasteners to structure.
h. Provide Shop Drawings illustrating each type of branchline restraint and sway brace, including length of sway brace member, sway brace fittings, minimum and maximum angles from vertical of sway brace member, method of attachment to structure, size, length and embedment of attachment to structure and size and type of structural member to which sway brace will be attached. Number each type of restraint and sway brace. Indicate on Drawings locations of each type of numbered restraint and sway brace.
i. Provide Shop Drawings illustrating information for Sprinkler System General Information Sign.
j. Shop Drawings to include a cross-Sectional view that shows the sprinkler heads and piping in relation to the building's architectural and structural information. View to be chosen based on a location that will display the most information.
k. When required, provide Coordination Drawings.
l. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
m. Provide details of hanger, sway bracing and branch line restraint attachments to structure and to piping. Include details on the size and load capacities of fasteners. Provide verification of the structural capacity to withstand seismic load.
n. Provide sway bracing calculations on drawings showing horizontal seismic design load and requirements, with indication of zone of influence for each bracing location.
o. Provide a schedule of sway bracing type, size, and design criteria, including length, angle from vertical, and load capacities.
p. Clearly indicate the elevation of the highest sprinkler in relation to the elevation of the flow test pressure gauge monitor hydrant.
q. Provide details of flexible branch line connectors per manufacturer's schedule of equivalent feet used in hydraulic calculations, showing connector device length, maximum number of 90-degree bends and expected radius of bends.

12. Samples: Provide samples when requested by individual Sections.
13. Resubmission Requirements:
    a. Make any corrections or change in submittals when required. Provide submittals as specified. The Engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Clearly indicate changes on Drawings and cloud changes in the submittals.
    b. Resubmit for review until review indicates no exceptions taken or make "corrections as noted".
14. Operation and Maintenance Manuals/Owners Instructions:
    a. Submit, at one time, electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or Item requiring servicing. Include valve charts. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
        1) Include copies of certificates of code authority acceptance, code-required acceptance tests; test reports and certificates.
        2) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Sections.
        3) Catalog description of each Item of equipment actually installed on job.
        4) Instructions for operation and maintenance of fire suppression systems composed of operating instructions, maintenance instructions and manufacturer's literature as follows:
            (a) Testing and Maintenance Schedule Chart: Provide an 8-1/2- by 11-inch typewritten list of each item of installed equipment requiring testing

inspection , lubrication or service, describing and scheduling performance of maintenance.

(b) Manufacturer's Literature: Provide copies of manufacturer's instructions for operation and maintenance of fire suppression equipment, including replacement parts list with name and address of nearest distributor. Mark each copy with equipment identification label as listed in equipment schedule, i.e. F-5 etc.

5) Include product certificates of warranties and guarantees.
6) Include Record Drawings,
7) Include copy of water supply flow test used as basis for hydraulic calculations.
8) Include hydraulic calculations and sway brace calculations.
9) Include Contractor's Material and Test Certificates for Aboveground Piping/Underground Piping.
10) Include a copy of NFPA 25.
11) Include a copy of valve charts and whether normally open or normally closed.
12) Include a copy of drain, auxiliary, and low point drains charts.
13) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
14) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, and quantities relevant to each piece of equipment: i.e. belts, motors, lubricants, and filters.
15) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub-assemblies.
16) Include copy of startup and test reports specific to each piece of equipment.
17) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.

b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 21 00 00, Fire Suppression Basic Requirements, Article titled "Demonstration".
c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

15. Record Drawings:
    a. Maintain at site at least one set of Drawings for recording “As-constructed” conditions. Indicate on Drawings changes to original documents by referencing revision document, and include buried elements, location of cleanouts, and location of concealed mechanical Item. Include items changed by field orders, supplemental instructions, and constructed conditions.
    b. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.
    c. At completion of project, input changes to original project on Revit Model and make one set of black-line drawings created from Revit Model in version/release equal to contract drawings. Submit Revit disk and drawings upon substantial completion.
    d. Invert elevations and dimensioned locations for water services and drainage piping below grade extending to 5-feet outside building line.

e. Record Drawings to include site information or reference site information for complete understanding of the fire protection system between the building and the point of connection to the water supply and location of flow test pressure hydrants.
f. See Division 21, Fire Suppression individual Sections for additional items to include in Record Drawings.

16. Calculations: Submit hydraulic and sway brace and the like calculations.
    a. Hydraulic Calculations:
        1) Include friction losses between the hydraulically most remote design area and the hydrant flow test pressure hydrant.
        2) Hydraulic calculations to be performed on a nationally recognized fire sprinkler hydraulic calculation computer program, with cover sheets in the format required by the latest edition of NFPA 13. Hydraulic calculations performed “by hand” or not on a nationally recognized fire sprinkler hydraulic calculations computer program will be returned without review by engineer.
        3) Provide one or more hydraulic calculations for each hydraulically most remote area.
        4) Where it is not obvious which area is most hydraulically remote, perform and submit for review additional hydraulic calculations proving the hydraulically most remote area.
        5) For grid systems, either provide “peaked” hydraulic calculations, or provide two additional sets of hydraulic calculations for each hydraulically most remote area.
        6) Include pressure losses between the highest sprinkler and the elevation of the pressure gauge monitor hydrant of the flow test.
        7) Include friction loss for flexible branch line connectors per manufacturer's schedule of equivalent feet for device length, maximum number of bends and expected radius of bends.
    b. Sway Brace Calculations:
        1) Sway brace calculations utilizing a proprietary computer calculation program only used for the sway brace components supported by that manufacturer. For example, only “manufacturer X” sway brace components, and not those of another manufacturer, may be calculated on a "manufacturer X” sway brace computer calculation program.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements: Work and materials installed to conform with all local, State, Federal and other applicable laws and regulations.

B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. They are not intended to show every Item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.

C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.

D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.

E. Provide products which are UL listed.

1.06 WARRANTY

A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.

B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.07 COORDINATION DOCUMENTS

A. Prior to construction, prepare and submit coordinated layout drawings (composite drawings), to coordinate installation and location of ductwork, grilles, diffusers, piping, fire sprinklers, fire alarm, plumbing, cable trays, lights, and electrical services. Composite Drawings show services on single sheet. Key Drawings to structural column identification system. Prior to completion of Drawings, coordinate proposed installation with architectural and structural requirements, and other trades (including plumbing, HVAC, electrical, fire alarm ceiling suspension and tile systems, etc.), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling and finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence. Unless otherwise required by Division 00, Procurement and Contracting Requirements and/or Division 01, General Requirements, Division 23, HVAC to combine information furnished by other trades onto master coordination documents.

B. Prepare Drawings as follows:
   1. Provide drawings in Revit Model. Revit Model release equal to design documents. Drawings to be same sheet size and scale as Contract Drawings and indicate location, size and elevation above finished floor of equipment and distribution systems.
   2. Review and revise, as necessary, Section cuts in Contract Drawings after verification of field conditions.
   3. Indicate fire protection system piping including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
   4. Indicate inverts and provision for piping that must be graded to have right-of-way over more flexible Item. Drawings also to indicate proposed ceiling grid and lighting layout as shown on electrical drawings, architectural reflected ceiling drawings and HVAC equipment, ductwork and piping. Drawings to indicate proposed and identified structural members to which hangers and sway braces will be attached as shown on structural drawings.
   5. Incorporate Addenda Item and change orders.
   6. Provide additional coordination as requested by other trades.

C. Advise Architect in event conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.

D. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.

E. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide like Item from one manufacturer, including but not limited to sprinkler heads, pipe, fittings, hangers and bracing materials.

2.02 MATERIALS

A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL, ETL, FM, and ICC-ES approved for their intended fire protection function or have adequate approval or be acceptable by State, County, and City authorities.

B. Articles, fixtures and equipment of a kind to be standard product of one manufacturer.

C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

D. Hazardous Materials:
   1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
   2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
   3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.03 ACCESS PANELS

A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.

B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 21, Fire Suppression Sections. In absence of specific requirements, comply with the following:
   1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
      a. Ceiling access panels to be minimum of 24-inch by 24-inch required and approved size.
      b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
      c. Provide screwdriver operated catch.
      d. Manufacturers and Models:
         1) Drywall: Karp KDW.
         2) Plaster: Karp DSC-214PL.
         3) Masonry: Karp DSC-214M.
         4) 2 hour rated: Karp KPF-350FR.
         5) Manufacturers: Karp, Milcor, Elmdor, Acudor or approved equivalent.

PART 3 - EXECUTION

3.01 ACCESSIBILITY AND INSTALLATION

A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.

B. Install equipment requiring access (i.e. drains, control operators, valves, motors, engines, pumps, controllers, air compressors, gauges, fill cups, tanks, cleanouts and the like) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.

C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines.

D. Earthwork:
   1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with the following:
      a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with the provisions specified. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
      b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.

c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.

E. Firestopping:
1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM International E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

F. Pipe Installation:
1. Coordinate work to account for expansion and contraction of piping materials and building as well as anticipated settlement or shrinkage of building. Install work to prevent damage to piping, equipment, and building and its contents. Provide piping offsets, loops, expansion joints, sleeves, anchors or other means to control pipe movement and minimize forces on piping. Verify anticipated settlement and/or shrinkage of building. Verify construction phasing, type of building construction products and rating coordinating installation of piping systems.
2. Include provisions for servicing and removal of equipment without dismantling piping.

G. Plenums:
1. Provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.

H. Utility Tunnels:
1. Contractor will coordinate with other trades for services installed within the utility tunnels. Service piping shall be installed such as to maintain a clear passage for a repairman to move and work inside the tunnels.
a. A 24-inch cross-sectional area will be provided along all portions of the tunnel for service access. This area shall extend from the bottom to top of the tunnel.
b. The floor shall be maintained clear from any pipe installations. Should piping be proposed for the service access area, it will be submitted as a shop drawing for review and acceptance prior to pipe installation.
c. The utility tunnels will be left clean with no construction debris.

3.02 SEISMIC CONTROL

A. Confirm Seismic Control requirements in Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.

B. Equipment Importance Factor: 1.5.

C. General:
1. Confirm Building Occupancy Category and Seismic Design Category with Structural Engineer.
2. Provide fire suppression equipment and piping, both hanging and base mounted, with mounting connection points of sufficient strength to resist lateral seismic forces equal to 0.5 of equipment operating weight or lateral seismic forces as determined by building code and NFPA 13 calculations, whichever is more demanding.
3. See Structural Drawings for seismic design criteria for sway bracing and seismic restraint.
4. Earthquake resistant designs for Fire Protection (Division 21, Fire Suppression) equipment and distribution, i.e. fire sprinkler systems, fire standpipe systems, fire pumps, fire pump controllers, fire tanks, clean agent fire suppression systems, etc. conform conform to regulations of jurisdiction having authority.
5. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in

such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.

6. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for piping, equipment, tanks, pumps controllers and the like. Submit shop drawings along with equipment submittals.
7. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details. Coordinate exact design requirements with project Structural Engineer.
8. Provide details of flexible sprinkler hose assembly for sprinklers in conformance with Building Code and ASCE 7 requirements of ceilings. Coordinate with Architectural and Structural Drawings and Specifications. Include on detail information pertaining to model number, listed number of bends, and listed equivalent length of 1-inch schedule 40 piping.

D. Piping: Per NFPA 13, ASCE-7 and local requirements.

E. Equipment:
1. Per "Seismic Restraints Manual Guidelines for Mechanical Systems" latest edition published by SMACNA, ASCE 7 and local requirements.
2. Provide means to prohibit excessive motion of fire protection equipment during an earthquake.

3.03 REVIEW AND OBSERVATION

A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.

B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
1. Underground piping installation prior to backfilling.
2. Prior to covering walls.
3. Prior to ceiling cover/installation.
4. When main systems, or portions of, are being tested and ready for inspection by AHJ.
5. When mains or branchlines are to be permanently concealed by construction or insulation systems.
6. When fire suppression systems, or portions of, are being tested and ready for inspection by AHJ.

C. Bear responsibility and cost to make piping accessible, to expose concealed lines, or to demonstrate acceptability of the system. If Contractor fails to notify Architect at times prescribed above, costs incurred by removal of such work are the responsibility of the Contractor.

D. Final Punch: Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.04 CONTINUITY OF SERVICE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
1. During remodeling or addition to existing structures, while existing structure is occupied, current services to remain intact until new construction, facilities or equipment is installed.
2. Prior to changing over to new service, verify that every Item is thoroughly prepared. Install new piping, and wiring to point of connection.
3. Coordinate transfer time to new service with Owner. If required, perform transfer during off peak hours. Once changeover is started, pursue to its completion to keep interference

at a minimum. If overtime is required, there will be no allowance made by Owner for extra expense for such overtime or shift work.

4. During entire time system, or part thereof, is not operational, provide a firewatch per Fire Code, including a watchperson whose sole duty is to watch for and report fires.
5. Organize work to minimize duration of power interruption.

3.05 CUTTING AND PATCHING

A. Confirm Cutting and Patching requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
   1. Cutting and patching performed under Division 21, Fire Suppression includes, but is not limited to:
      a. Cutting and patching of plaster or partitions.
      b. Cutting and patching of finished ceilings.
   2. Perform cutting and patching by skilled craftsmen in trade of work to be performed. Fill holes which are cut oversized for completed work. Match refinished areas with existing adjacent finish in a manner acceptable to Architect.
   3. When masonry to concrete construction must be penetrated, provide a steel pipe sleeve in opening and grout in place in a neat manner. Leave grout surface to match existing finish. Provide escutcheons. If sleeves are not provided, core drill penetrations.
   4. Locate concealed utilities to eliminate possible service interruption or damage.
   5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.
   6. Proposed floor cutting/core drilling/sleeve locations to be approved by project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
   7. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
   8. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
   9. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, landscaping, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
   10. Repair mutilation of building around pipes, equipment, hangers, and braces.

3.06 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing at no additional cost to Owner.

3.07 DELIVERY, STORAGE AND HANDLING

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
   1. Handle materials delivered to project site with care to avoid damage and deterioration. Store materials in original containers which identify manufacturer, name, brand and model numbers on site inside building or protected from weather, sun, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced

before installation. Products and/or materials that become damaged due to water, dirt and/or dust as a result of improper storage to be replaced before installation.

2. Protect equipment and pipe to avoid damage. Close pipe openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
3. Protect bright finished shafts, bearing housings and similar Item until in service.

3.08 DEMONSTRATION

A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.

B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.

C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

D. Prior to acceptance of work and during time designated by Architect, provide necessary qualified personnel to operate system for a period of four hours.

E. Instruct the Owner in the operation of the sprinkler system, including main valve position (open or closed) recognition, system drainage, system testing, dry pipe valve reset and the relation to the fire alarm system.

F. Upon completion of work and adjustment of equipment, test systems to demonstrate to Owner's Representative and Architect that equipment is furnished and installed or connected under provisions of these Specifications.

3.09 CLEANING

A. Confirm Cleaning requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.

B. Upon completion of installation, except for sprinklers, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

C. Sprinklers may not be cleaned except for vacuuming in a manner in which no part of the sprinkler is touched by the vacuuming equipment. Replace sprinklers which bear traces of foreign substances with sprinklers of same model, temperature, K-factor, orifice, finish, style, orientation, and the like.

3.10 INSTALLATION

A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.

B. Install equipment in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

C. Start-up equipment, in accordance with manufacturer's start-up instructions, in the presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

1. Provide pump impellers to obtain Basis of Design design capacities.

D. Provide miscellaneous supports/metals required for installation of equipment and piping.

3.11 PAINTING

A. Confirm requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
   1. Ferrous Metal: After completion of fire protection work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces, i.e., hangers, hanger rods, equipment stands, with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
   2. After acceptance by AHJ, in a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
   3. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
   4. Piping: Clean, primer coat and paint exposed piping on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.
   5. Covers: Covers such as vault covers and the like will be furnished with finishes which resist corrosion and rust.

3.12 ACCESS PANELS

A. Confirm Access Panel requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
   1. Coordinate locations/sizes of access panels with Architect prior to work. Label access panels with engraved nameplates indicating function of panel.

3.13 DEMOLITION

A. Confirm Demolition requirements in Division 01, General Requirements and Division 02, Existing Conditions. In absence of specific requirements, comply with individual Sections in Division 21, Fire Suppression and the following:
   1. Scope:
      a. It is the intent of these documents to provide necessary information and adjustments to fire protection system required to meet code, and accommodate installation of new work.
      b. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
      c. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged Item with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
   2. Equipment and Piping: Unless otherwise directed, equipment, piping, or fittings being removed as part of demolition process are Owner's property. Remove other Item not scheduled to be reused or relocated from job site as directed by Owner.
   3. Unless specifically indicated on Drawings, remove exposed, unused piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap piping and patch surfaces to match surrounding finish.
   4. Unless specifically indicated on Drawings, remove unused equipment, fittings, rough-ins, and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).
   5. Coordinate demolition of existing fire suppression systems with Contractor. Where applicable or possible, portions of fire suppression demolition work may be performed by Contractor. Verify with local AHJ as to limitations of demolition by others and not fire suppression trades. Coordinate extent of demolition of fire suppression work to be done

by others and supervise this work. No extra costs will be approved by replacement of systems due to improper or excessive demolition.

3.14 ACCEPTANCE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Sections in Division 21, Fire Suppression and the following:
   1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
      a. Testing reports including Contractor's Material and Test Certificate for Underground Piping, Contractor's Material and Test Certificate for Aboveground Piping, Contractor's Material and Test Certificate for Private Fire Service Mains, Fire pump acceptance test data report, and the like.
      b. Cleaning
      c. Operation and Maintenance Manuals
      d. Training of Operating Personnel
      e. Record Drawings
      f. Warranty and Guaranty Certificates
      g. Start-up/Test Document and Commissioning Reports
      h. Letter of Conformance

3.15 FIELD QUALITY CONTROL

A. Confirm Field Quality Control requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.

B. Upon completion of installation of equipment, sprinklers, hose valves and piping and after units are water pressurized, test system to demonstrate capability and compliance with requirements. When possible, correct malfunctioning Item at site, then retest to demonstrate compliance; otherwise remove and replace with new Item and proceed with retesting.

C. Inspect each installed Item for damage to finish. If feasible, restore and match finish to original, except fire sprinklers, at site; otherwise, remove Item and replace with new Item Feasibility and match to be judged by Architect. Remove cracked or dented Item and replace with new Item.

D. Fire sprinklers may not be reused, or cleaned, except for dusting. Replace damaged, field painted, oversprayed, overcoated or field coated sprinklers with new sprinklers of same manufacturer, model, finish, K-factor and performance characteristics. Where identical replacement sprinklers are not available, provide sprinklers of similar finish, style, K-factor and performance characteristics.

3.16 LETTER OF CONFORMANCE

A. Provide Letter of Conformance and copies of manufacturers' warranties and extended warranties with a statement that fire suppression items were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include Letter of Conformance, copies of manufacturers' warranties and extended warranties in Operation and Maintenance Manuals.

3.17 ELECTRICAL INTERLOCKS

A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize fire protection equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.

3.18 CONNECTIONS TO EXISTING

A. Prior to connection of piping to existing piping or utilities, field verify existing conditions and exact sizes and locations of existing piping. Provide additional offsets, transitions, joints, cut-ins, and replace portions of existing as required to facilitate connections of new.

END OF SECTION

SECTION 21 0500
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
1. Product Standards
2. Fire-Suppression Screw Thread Connections
3. Buried Ductile Iron Pipe and Fittings
4. Aboveground Black Steel Pipe and Fittings
5. Seismic Separation Assembly
6. Flexible Sprinkler Hose Assembly
7. Wall and Floor Penetrations and Sleeves
8. Inspector's Test Connection
9. Floor Control Assembly
10. Riser Manifold
11. Switches, Valve Supervisory
12. Switches, Water Detector
13. Hangers and Supports
14. Sway Braces and Restraints
15. Anchors and Attachments
16. Pipe Stands
17. Gauges
18. Bells
19. Fire Department Connections
20. Valves
21. Pipe Valve and Fire Protection Equipment Identification
22. Signs
23. Drains

1.02 RELATED SECTIONS

A. Contents of Division 21, Fire Suppression and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
1. Division 22, Plumbing
2. Division 23, Heating, Ventilating and Air Conditioning
3. Division 26, Electrical
4. Division 28, Electronic Safety and Security
5. Division 31, Earthwork

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.07 FLOW TEST

A. Flow: 1987 GPM at a residual pressure of 55 PSI.
B. Static Pressure: 77 PSI.
C. Location: W 22nd and Fillmore, Hydrant #769 (flow test based on hydraulic model).
D. Elevation: Unknown.
E. Date: 10/15/2015.
F. Information Provided By: EWEB.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Buried Ductile Iron Pipe and Fittings:
   1. American Cast Iron Pipe Co.
   2. Atlantic States Cast Iron Pipe Co.
   3. Clow Water Systems Co.
   4. Griffin Pipe Products Co.
   5. McWane Cast Iron Pipe Co.
   6. Pacific States Cast Iron Pipe Co.
   7. United States Pipe & Foundry Co.
   8. Or approved equivalent.

B. Aboveground Black Steel Pipe and Fittings:
   1. Pipe:
      a. Allied Tube & Conduit corp.
      b. Bull Moose Tube
      c. Wheatland Tube Co.
      d. Youngstown Tube Co.
      e. Tex-Tube Co.
      f. Or approved equivalent
   2. Fittings, Mechanical and Grooved Couplings:
      a. Victaulic
      b. Gruvlok
      c. Shurjoint Piping Products Inc.
      d. Smith-Cooper International
      e. Tyco Fire & Building Products
      f. Viking S.A.
      g. Or approved equivalent.
   3. Fittings, Threaded:
      a. Smith-Cooper International
      b. Anvil International
      c. Ward Mfg.
      d. Or approved equivalent.
   4. Fittings, Rubber Gasketed:
      a. Anvil International
      b. AnvilStar
      c. Ebaa Iron, Inc.
      d. Shurjoint Piping Products, Inc.
      e. Smith-Cooper International
      f. Tyco Fire & Building Products
      g. Victaulic Co.
      h. Viking S.A.
      i. Ward Mfg.
      j. Or approved equivalent.

C. Seismic Separation Assembly:
   1. Metraflex
   2. Or approved equivalent.
D. Flexible Sprinkler Hose Fittings:
   1. Flexhead Industries
   2. SprinkFLEX
   3. Victaulic VicFlex
   4. Or approved equivalent.
E. Inspector's Test Connection:
   1. AGF
   2. Or approved equivalent.
F. Floor Control Assembly:
   1. Viking
   2. Victaulic
   3. Reliable
   4. Or approved equivalent.
G. Riser Manifold:
   1. Viking
   2. Reliable
   3. AGF
   4. Or approved equivalent.
H. Switches, Valve Supervisory:
   1. Outside Screw and Yoke Valve Supervisory Switch:
      a. Potter
      b. System Sensor
      c. Or approved equivalent.
   2. Post Indicator Valve (PIV) Control Valve Supervisory Switch:
      a. Potter
      b. System Sensor
      c. Or approved equivalent.
   3. Non-Rising Stem Valve Supervisory Switch:
      a. Potter
      b. System Sensor
      c. Or approved equivalent.
   4. Ball Valve Supervisory Switch:
      a. Potter
      b. System Sensor
      c. Or approved equivalent.
   5. Angle Valve Supervisory Switch:
      a. System Sensor
      b. Or approved equivalent.
I. Switches, Water Detector:
   1. Water Flow Switches:
      a. Wet Sprinkler Systems:
         1) Potter
         2) System Sensor
         3) Or approved equivalent.
   2. Pressure Operated Alarm Switches:
      a. Dry Pipe Sprinkler Systems:
         1) Potter
         2) System Sensor
         3) Or approved equivalent.

J. Hangers and Supports:
   1. Cooper B-Line Tolco
   2. Afcon
   3. Anvil International
   4. ITW Buildex Sammys
   5. Or approved equivalent.

K. Sway Braces and Restraints:
   1. Cooper B-Line Tolco
   2. Afcon
   3. Or approved equivalent.

L. Anchors and Attachments:
   1. Cast-In Place Anchors:
      a. Cooper B-Line Tolco
      b. Afcon
      c. Or approved equivalent.
   2. Attachments:
      a. Hilti
      b. Powers
      c. Or approved equivalent.

M. Pipe Stands:
   1. Cooper B-Line Tolco
   2. Afcon
   3. Anvil International
   4. Or approved equivalent.

N. Gauges:
   1. Ashcroft
   2. US Gauge
   3. Brecco
   4. Or approved equivalent.

O. Bells:
   1. Potter
   2. System Sensor
   3. Or approved equivalent.

P. Fire Department Connections:
   1. Guardian
   2. Croker
   3. Or approved equivalent.

Q. Valves:
   1. OS&Y Gate:
      a. 175 PSI:
         1) Nibco
         2) Mueller
         3) Or approved equivalent.
      b. 250 PSI:
         1) Victaulic
         2) Or approved equivalent.
      c. 350 PSI:
         1) Nibco
         2) Or approved equivalent.
      d. 2-inches and Smaller:
         1) Nibco
         2) Or approved equivalent.

2. NRS Gate:
    a. 175 PSI:
        1) Nibco
        2) Or approved equivalent.
    b. 200 PSI:
        1) Mueller
        2) Or approved equivalent.
    c. 250 PSI:
        1) Victaulic
        2) Or approved equivalent.
3. Swing Check:
    a. Nibco
    b. Mueller
    c. Viking
    d. Tyco
    e. Or approved equivalent.
4. Wafer Check:
    a. Nibco
    b. Mueller
    c. Viking
    d. Tyco
    e. Or approved equivalent.
5. Butterfly Valves:
    a. Nibco
    b. Tyco
    c. Or approved equivalent.
6. Pressure Relief:
    a. Watts
    b. United Brass Works
    c. AGF
    d. Or approved equivalent.
7. Automatic Ball Drip Drain Valve:
    a. Tyco
    b. Or approved equivalent.

R. Post Indicating Valve Assemblies:
1. Nibco
2. Kennedy
3. Mueller
4. United Water Products
5. Henry Pratt Company
6. Or approved equivalent.

2.02 PRODUCT STANDARDS

A. Material and Equipment: Listed for its intended fire protection use in current UL Fire Protection Equipment Directory, or UL Online Certifications Directory for Fire Protection, International Code Council Evaluation Service Reports or FM Global Approval Guide, new and of current manufacture.

B. Where pressures are expected to exceed 175 PSI, provide products for high pressure or extra high pressure service.

C. Provide per AHJ requirements.

D. References to product Specifications for materials are listed according to accepted base standards. Materials to meet latest approved versions of these standards.

E. See Section 21 00 00, Fire Suppression Basic Requirements where piping materials are approved for use.

2.03 FIRE-SUPPRESSION SCREW THREAD CONNECTIONS

A. Comply with local fire department/fire marshal regulations for sizes, threading and arrangement of connections for fire department equipment to fire department connections and standpipe systems.

2.04 BURIED DUCTILE IRON PIPE AND FITTINGS

A. Pipe:
   1. Class 52 ductile iron, AWWA C151, 150 psi or 10.34 bar.
   2. Cement mortar lined, factory encased with 8 mil polyethylene tube or sheet or seal coat per AWWA C104.

B. Fittings:
   1. AWWA C110, 250 psi or 17.24 bar. Cement mortar lined. Seal coat: AWWA C104. Double field wrapped with 5 cm, 20 mil vinyl tape, 50 percent overlap, Scotch Wrap No. 51.
   2. Fittings restrained with thrust blocks per NFPA 24.

2.05 ABOVEGROUND BLACK STEEL PIPE AND FITTINGS

A. Wet Pipe Systems:
   1. Pipe Size 2-inch Diameter and Smaller: ASTM A53, ASTM A135, or ASTM A795; minimum of Schedule 40.
   2. Pipe Size 2-1/2-inch Diameter and Larger: ASTM A53, ASTM A135, or ASTM A795; Schedule 10.
   3. Exposed pipe 8-feet or less above finished floor: A minimum of Schedule 40.

B. Dry Pipe Systems:
   1. Pipe Size 2-inch Diameter and Smaller: ASTM A53, ASTM A135, or ASTM A795; Schedule 40 only, threaded or cut grooved only.
   2. Pipe Size 2-1/2-inch Diameter and Larger: ASTM A53, ASTM A135, or ASTM A795; Schedule 40 or Schedule 10.

C. Exposed Pipe 8-feet or Less Above Finished Floor: A minimum of Schedule 40.

D. Joints:
   1. Threaded, flanged or bevel welded.
   2. Piping installed in plenums or shafts to have welded joints.

E. Fittings:
   1. Threaded:
      a. Malleable Iron: Class 150 and Class 300, ANSI B16.3.
      b. Cast Iron: Class 125 and 250, ANSI B16.3.
   2. Flanged: Cast iron; Class 125 and 250, ASME B16.1, raised ground face, bolt holes spot faced.
   3. Welded:
      a. Carbon Steel: Long radius, standard weight or extra strong.
      b. Factory Wrought Steel Buttweld Fittings: ASME B16.9.
      c. Buttwelding Ends for Pipe, Valves, Flanges and Fittings: ASME B16.25.
      d. Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures: ASTM A234.
      e. Steel Pipe Flanges and Flanged Fittings: ASME B16.5.
      f. Forged Steel Fittings, Socket Welded and Threaded: ASME B16.11.
   4. Fittings, Mechanical and Grooved Couplings:
      a. UL 213, AWWA C606, ASTM A536 ductile iron or ASTM A47 malleable iron, with enamel finish and grooves or shoulders designed to accept grooved couplings. Synthetic-rubber gasket with central-cavity, pressure-responsive design and ASTM A183 carbon-steel bolts and nuts.
      b. FM Global approved.

F. Anti-Microbial Coating: Factory-applied coating to inhibit corrosion from microbiological organisms.

2.06 SEISMIC SEPARATION ASSEMBLY

A. Flexible expansion loop, designed for seismic movement for sprinkler pipe passing through or crossing building seismic joints. Impart no thrust loads to building structure.

B. Two flexible Sections of hose and braid, two 90 degree elbows and 180 degree return. Factory supplied, center support nut located at the bottom of the 180 degree return, drain/air release plug. Provide materials of construction and end fitting type consistent with pipe material and equipment/pipe connection fittings. Metraflex Fireloop.

2.07 FLEXIBLE SPRINKLER HOSE ASSEMBLY

A. Fully welded non-mechanical fittings, braided, leak-tested with minimum 1-inch true-bore internal corrugated hose diameter. 175 psi. Ceiling bracket: Galvanized steel, direct attachment type, with integrated snap-on clip ends and removable flexible hose attachment with set screw. FM1637, UL 2443.

2.08 WALL AND FLOOR PENETRATIONS AND SLEEVES

A. Below Grade and High Water Table Areas: Elastomeric silicone watertight sealant.

B. Pre-Engineered Firestop Pipe Penetration Systems: UL Listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.

2.09 INSPECTOR'S TEST CONNECTION

A. Combination Test and Drain: Bronze body, brass stem, impregnated Teflon seat, chrome coated brass ball, steel handle with positive stops, tamper resistant test orifice, integral tamper resistant sight glasses, tapped and plugged port for system access, steel identification plate. Provide with pressure relief valve and drainage piping with bronze body and stainless steel spring. AGF TestAnDrain.

B. Dry System Inspector's Test Connection: Bronze, brass stem, steel handle, chrome-plated bronze ball, Teflon valve seat, tamper and corrosion resistant orifice equivalent to smallest sprinkler orifice, sight flow connection. AGF Model 3011 series.

2.10 FLOOR CONTROL ASSEMBLY

A. Water-flow alarm, gauge, integral pressure relief valve connected to drain, sight glass, smooth bore orifice union of same size as smallest orifice sprinkler installed.

B. Manufacturer: Viking EasyPac, Victaulic FireLock 747M or Reliable FCV.

2.11 RISER MANIFOLD

A. Water-flow alarm, gauge, integral pressure relief valve connected to drain, sight glass, smooth bore orifice union of same size as smallest orifice sprinkler installed.

B. Manufacturer: Viking EasyPac, Reliable CR or AGF 8011.

2.12 SWITCHES, VALVE SUPERVISORY

A. Provide to mount on applicable, compatible valve (OS&Y gate, or PIV), with SPDT switches to match requirements of fire alarm system. Provide with cover tamper switch where required by AHJ.
   1. Outside Screw and Yoke Valve Supervisory Switch: Potter OSYSU-1,-2; System Sensor OSY2 or OSYECP.
   2. Post Indicator Valve (PIV) Control Valve Supervisory Switch: Potter PCVS -1, -2; System Sensor PIBV2 or PIBVEXP.
   3. Non-Rising Stem Valve Supervisory Switch: Potter PTS-C or System Sensor PSP1.
   4. Ball Valve Supervisory Switch: Potter RBVS or System Sensor PSP1.
   5. Angle Valve Supervisory Switch: System Sensor PSP1.

2.13 SWITCHES, WATER DETECTOR

A. Provide with cover tamper switch where required by AHJ.

B. Water Flow Switches:
   1. Vane-type; SPDT switches; electronic retard, adjustable time delay (0 to 75 seconds).
   2. Wet Sprinkler Systems, NFPA 13: 450 PSI, 18-feet per second, 4-10 gpm, Potter VSR or System Sensor WFD series.

C. Pressure Operated Alarm Switches:
   1. Pressure actuated with SPDT electrical switches and adjustable time delay (0 to 75 seconds).
   2. Dry Pipe Sprinkler Systems: Detection of waterflow conditions. 1/2-inch NPT connection. Potter PS10, System Sensor EPS or EPS EXP series.
   3. Dry Pipe Sprinkler Systems: Detection of low pressure. Potter PS40, System Sensor EPS or EPS EXP series.

2.14 HANGERS AND SUPPORTS

A. General:
   1. Select size of hangers and supports to exactly fit pipe size for bare piping.

B. Hangers:
   1. Ferrous. Cooper B-Line Tolco, Afcon, Anvil International, or ITW Buildex Sammys.
   2. ITW Buildex Sammys with FM Approval only are not allowed in certain seismic zones. Verify with FM that FM Approval is effective in project's seismic zone.

C. Hanger Rods:
   1. Concealed Spaces: Continuously threaded or threaded ends.
   2. Exposed Spaces: Threaded ends.

D. Channel Type Strut and Strut Clamps: Only models UL Listed or FM Approved for fire protection.

2.15 SWAY BRACES AND RESTRAINTS

A. Sway Bracing: From a single manufacturer and compatible with sway brace calculation program.

2.16 ANCHORS AND ATTACHMENTS

A. General: Anchor supports to masonry, concrete and block walls per anchoring system manufacturer's recommendations, or as modified by project Structural Engineer.

B. Attachments in Concrete:
   1. Suitable for hanging and bracing fire protection systems in concrete which is subject to cracking in a seismic event.
   2. Compatible with International Code Council Evaluation Service Acceptance Criteria AC-193 and AC308 for expansion, screw and adhesive anchors.
   3. See Structural Drawings for additional information regarding acceptable attachments. Attachment products listed in structural Drawings and Specifications take precedence over the following products. If no structural Drawings or Specification provided, then choose from the following: Hilti Kwikbolt TZ, Powers - Snake+, Powers Power-Stud+SD2 or Powers Wedge-Bolt.
   4. Cast-in-Place Anchors: Cooper B-Line Tolco or Afcon.

2.17 PIPE STANDS

A. Adjustable Pipe Saddle Support with Yoke:
   1. Designed to support horizontal pipe from floor stanchion.
   2. U-bolt and hex nuts to hold pipe securely to saddle or pipe clamp type.
   3. ANSI/MSS SP-69; SP-58. Type 37.
   4. Steel pipe with steel saddle.
   5. Cooper B-Line Tolco Fig B3092 with Fig. B3088ST; Afcon 708 with 722, Anvil Fig. 259 with Fig. 62 or 63.

B. Base Stand:
   1. Steel pipe welded to steel base plate.

2. Meet requirements of 12X anchor diameter hole spacing for seismic applications.

2.18 GAUGES

A. Pressure Gauges: 3.5-inch, dial type, bronze bourdon tube or spring type, stainless steel case. 0 to 300 PSI.

B. 1005P-XUL, US Gauge 1590K.

2.19 BELLS

A. Alarm Bells - Exterior:
1. Minimum weatherproof backbox, typical 90 dBA at 10-feet.
2. Manufacturer: Potter PB 8-inch.

2.20 FIRE DEPARTMENT CONNECTIONS

A. General:
1. Thread to match fire department hardware; automatic drip connected to drain. Provide threaded dust cap and chain of same material and finish as body, or Fire Department required and approved Knox cap.
2. Provide with individual clappers.

B. Type: Free-Standing Type

C. Finish: Ductile Iron

D. Inlet Size: 2-1/2-inch.

E. Number of Inlets: Two.

F. Sign:
1. Auto Sprinkler Fire Department Connection
2. Provide additional signage as required by AHJ.

2.21 VALVES

A. OS&Y Gate:
1. 2-1/2-inches and Larger: Iron body.
2. 175 PSI: Nibco F-607-0 or Mueller R-2360-6.
3. 250 PSI: Victaulic 771.
4. 350 PSI: Nibco F697-0.
5. 2-inches and Smaller: Bronze body. Nibco T-104.

B. NRS Gate: Iron body. Non-rising stem with indicator post.
1. 175 PSI: Nibco M/F-609 with Nibco NIP1A for yard use.
2. 175 PSI: Nibco M/F-609 with Nibco NIP2A for wall use.
3. 200 PSI: Mueller A-2361 with Mueller A-2080x indicator post for yard use.
4. 200 PSI: Mueller A-2361 with Mueller A-20813 wall type indicator post for wall use.
5. 250 PSI: Victaulic 772, with Victaulic 774 indicator post for yard use.
6. 250 PSI: Victaulic 772, with Victaulic 773 wall type indicator post for wall use.
7. For underground butterfly valves, telescopic barrel typ. Henry Pratt Model G.

C. Swing Check: Iron body, rubber and bronze faced checks. Nibco F-908-W, Mueller A-2122-6, Viking Easy Riser Swing Check or Tyco CV-1F.

D. Wafer Check: Iron body, rubber seat, spring actuated. Nibco W-900-W, Mueller A2102, Viking or Tyco.

E. Butterfly Valves: Ductile iron body, Nibco WD3510-8, Tyco BFV-N, with factory-installed tamper switches or approved equivalent. Use lug body next to pumps, LD-3510-6.

F. Pressure Relief: Bronze body, stainless steel spring. Watts FP-53L or United Brass Works 132.

G. Automatic Ball Drip Drain Valve: Bronze, spring-type. Tyco AD-1,-2 or approved equivalent.

2.22 PIPE VALVE AND FIRE PROTECTION EQUIPMENT IDENTIFICATION

A. Engraved plastic laminate or corrosion resistant metal sign or plastic equipment marker.

B. Corrosion-resistant chain or permanent adhesive.

2.23 SIGNS

A. Engraved plastic laminate or corrosion resistant metal sign or plastic equipment marker.

B. Corrosion-resistant chain or permanent adhesive.

2.24 DRAINS

A. See Division 22, Plumbing for drain materials.

PART 3 - EXECUTION

3.01 MANUFACTURERS

A. Unless an item is marked "No substitutions", submit substitution request for materials of other than named manufacturers.

3.02 PRODUCT STANDARDS

A. Meet requirements of AHJ.

B. Install in conformance with UL Listing, RM Approval or ICC-ES requirements and restrictions.

3.03 FIRE-SUPPRESSION SCREW THREAD CONNECTIONS

A. Coordinate with requirements of local AHJ.

3.04 BURIED DUCTILE IRON PIPE AND FITTINGS

A. Pipe Sleeves:
   1. Lay out work in advance of pouring concrete and furnish and set sleeves necessary to complete work.
   2. Floor Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1-inch above finished floor. Caulk pipes passing through floor with nonshrinking firestopping, smokestopping and water stopping grout or approved equivalent caulking compound. Caulk/seal piping passing through fire rated building assembly with UL rated assemblies.
   3. Wall Sleeves: Provide sleeves on pipes. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with nonshrinking caulking compound. Caulk/seal piping passing through fire-rated building assemblies with UL Listed or FM approved fire-rated firestopping compound. Provide fire-rated assemblies per local AHJ requirements.
   4. Coordinate with trades for locations of pipe sleeves in reinforced concrete and steel beams. Penetrations must be indicated on structural shop drawings. See Drawings and Specifications for specific sleeve location limitations.

B. Conform to applicable codes and industry standards.

C. Excavate and backfill per Specification and NFPA 24.

3.05 ABOVEGROUND BLACK STEEL PIPE AND FITTINGS

A. Pressure Piping Routing:
   1. Route piping, except as otherwise indicated, vertically and horizontally (sloped to drain). Avoid diagonal runs wherever possible. Orient horizontal routes parallel with walls and beam lines.
   2. Install piping as shown or described by diagrams, details and notations on Drawings or, if not indicated, install piping to provide the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.
   3. In areas visible to public, route and install pipe so as to minimize visual impact.
   4. Support piping adjacent to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 2-inches wherever furring is indicated for concealment of piping. Allow for insulation thickness. Locate insulated piping to provide minimum 1-inch clearance outside insulation.
   5. Wherever possible in finished and occupied spaces, conceal piping from view by locating within column or beam enclosures, hollow wall construction, or above suspended ceilings. Do not encase horizontal routes in solid partitions, except where approved.

6. Route non-preaction piping around areas protected by preaction sprinkler systems.

B. Couplings:
   1. Install where indicated on Drawings and on each side of pieces of equipment to permit easy removal of equipment.
   2. Deburr cut edges.

C. Pipe Penetrations: Wire pipe cutout coupon at point of pipe penetration.

3.06 SEISMIC SEPARATION ASSEMBLY

A. Provide four-way sway braces upstream and downstream within 6-feet of the seismic separation assembly, attached to structure on opposite sides of the seismic joint. Do not attach bracing to seismic separation assembly.

3.07 FLEXIBLE SPRINKLER HOSE ASSEMBLY

A. For hydraulic calculations, include friction loss per manufacturer's schedule of equivalent feet for most demanding bend radius and maximum number of bends per UL Listing or FM Approval, whichever is most demanding.

B. Install with no more bends than are included in equivalent footage used in hydraulic calculations.

C. Maintain manufacturer's recommended bending radius as included in equivalent footage used in hydraulic calculations.

3.08 WALL AND FLOOR PENETRATIONS AND SLEEVES

A. Escutcheons: Install on exposed pipes passing through walls or floors.
   1. Pipe Sleeves: Lay out work in advance of pouring concrete and furnish and set sleeves necessary to complete work.
   2. Floor Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1-inch above finished floor. Caulk pipes passing through floor with nonshrinking fire and water resistant grout or approved equivalent caulking compound. Caulk/seal piping passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
   3. Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with non-shrinking caulking compound. Caulk/seal piping passing through fire-rated building assemblies with UL Listed or FM Approved fire-rated firestopping compound. Provide fire-rated assemblies per local AHJ requirements.
   4. Beam Sleeves:
      a. Coordinate with trades for locations of pipe sleeves in reinforced concrete and steel beams. Penetrations must be indicated on structural shop drawings. See Drawings and Specifications for specific sleeve location limitations. Pipe sleeve locations must be indicated on reinforced concrete and steel beam shop drawings. Field cutting of beams not allowed without written approval of structural engineer. No extra costs allowed for failure to coordinate beam penetrations prior to reinforced concrete and steel beam shop drawing submittal.
      b. Firestopping penetrations in fire-rated wall/floor assemblies.
      c. Reference Division 07, Thermal and Moisture Protection.
      d. Coordinate with Drawings location of fire rated walls, ceilings and floors. When these assemblies are penetrated, seal around piping and equipment with approved firestopping material.
      e. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814 and NFPA.
      f. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814.

3.09 INSPECTOR'S TEST CONNECTION

A. Route water supply flow test connections to a location which can accept the flow under wide-open flow and pressure for a sufficient time to assure a proper test and which will not cause damage, including to landscaping.

B. Install conveniently and accessibly located with reference to finished building for repairs, removal and service.

3.10 FLOOR CONTROL ASSEMBLY

A. Install so valves and gauges are conveniently and accessibly located with reference to finished building for repairs, removal and service.

B. Provide connection from pressure relief valve to drain.

3.11 RISER MANIFOLD

A. Install so valves and gauges are conveniently and accessibly located with reference to finished building for repairs, removal and service.

3.12 SWITCHES, VALVE SUPERVISORY

A. Coordinate with Division 28, Electronic Safety and Security.

3.13 SWITCHES, WATER DETECTOR

A. Wire pipe cutout coupon at point of connection of switch to pipe.

B. Flow switches: Connect to system side of valves and drain connections.

C. Coordinate with Division 28, Electronic Safety and Security.

3.14 HANGERS AND SUPPORTS

A. General:
   1. Installation of Pipe Hangers, Inserts and Supports: Conform to NFPA 13.
   2. Provide adjustable hangers, inserts, brackets, clamps, supplementary steel and other accessory materials required for proper support of pipe lines and equipment. Provide supplementary materials for proper support and attachment of hangers.

B. Finishes:
   1. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
   2. Use non-metallic coatings such as plastic, felt, epoxy paint, or non-adhesive isolation tape on attachments for electrolytic protection where attachments are in direct contact with dissimilar metals such as copper tubing.

C. Materials:
   1. Use carbon steel pipe hangers and supports, metal trapeze pipe hangers and attachments for general service applications.
   2. Use corrosion-resistant attachments for highly corrosive or hostile environment applications.
   3. Use copper coated or plastic coated pipe hangers and copper attachments for copper piping and tubing.

D. Anti-Scratch Padding: Use padded hangers for piping subject to scratching.

3.15 SWAY BRACES AND RESTRAINTS

A. Locate per orientation and spacing as required by sway brace calculations.

B. Attach sway bracing directly to pipe or equipment being braced.

C. Do not attach sway bracing to bottom of truss members.

D. Provide seismic calculations for any sway brace to be attached to any I-joist according to the specifications of the I-joist manufacturer.

3.16 ANCHORS AND ATTACHMENTS

A. In post-tension construction, determine location of post-tension cables and install anchors to avoid contact or interference with post-tension cables. Coordinate with Structural.

B. Do not use powder-driven attachments.

C. Building Attachments and Inserts: Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves and flanges, for sizes NPS 2-1/2 and larger. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

D. Hanger and Support Attachments:
   1. Concrete:
      a. Before Pouring: Support piping and equipment from malleable iron concrete form inserts placed before concrete is poured.
      b. After Pouring:
         1) Where supports in slabs are required after concrete has been poured, provide drilled-in threaded inserts (mechanical-expansion anchors), installed in accordance with manufacturer's recommendations.
         2) Install mechanical-expansion anchors after concrete is completely cured and in accordance with manufacturer's installation instructions.
   2. Metal Floor Deck: Support hangers per UL Listing or FM Approval for selected concrete insert before pouring of concrete topping, or from beam clamps fastened to structural steel.
   3. Steel Joists: Support hangers from beam clamps fastened to bar joists or to auxiliary steel between bar joists as required.
   4. C-Clamp Hangers: Do not attach to one side of double-angle bottom members.

3.17 PIPE STANDS

A. Secure to floor.

B. Install to maintain pipe level and plumb.

C. Securely attach to supported pipe by U-Bolt.

3.18 GAUGES

A. Install gauges conveniently and accessibly located with reference to finished building for repairs, removal and service.

B. Install with dial positioned for maximum visibility.

3.19 BELLS

A. Locate exterior alarm bells at 8-feet above finished grade. Coordinate with Architect.

B. Coordinate with Divisions 26, Electrical and Division 28, Electronic Safety and Security.

3.20 FIRE DEPARTMENT CONNECTIONS

A. Locate with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.

B. Provide method of draining FDC piping. Drain to sanitary sewer by indirect connection, or to exterior where damage, including damage to landscaping and staining of concrete, will not occur.

C. Locate away from building egress paths. Coordinate location with Fire Marshal.

3.21 VALVES

A. General:
   1. Provide post indicator on buried control valves.
   2. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.

B. Installation:

1. Install valves where required for proper operation, testing and drainage. Locate valves so as to be accessible and so that separate support can be provided when necessary. Install conveniently and accessibly located with reference to finished building for repairs, removal and service.
2. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow.
3. Wafer Check Valves: Install between two flanges in horizontal or vertical position, position for proper direction of flow.

C. Pressure Relief Valves: Provide piping to permanent drain.

D. Pressure Reducing/Regulating Valves:
1. Provide separate, supervised, control valve on each side of pressure regulating valve.
2. Provide pressure gauge on each side of pressure reducing and pressure regulating valves.

3.22 PIPE VALVE AND FIRE PROTECTION EQUIPMENT IDENTIFICATION

A. Install engraved plastic laminate or corrosion resistant metal sign or plastic equipment marker, secured with corrosion-resistant chain or permanent adhesive on or near each Item of fire suppression equipment and each operational device, as specified in this specification if not otherwise specified for each Item or device. Provide signs for the following general categories of equipment and operational devices: Valves, drains, pumps, standpipes, tanks and similar equipment. Provide valve tag on every valve and control device in each piping system. Exclude check valves and valves within factory fabricated equipment units. List each tagged valve in valve schedule for each piping system.

B. Each new piece of equipment to bear a permanently attached identification plate, listing manufacturer's name, capacities, sizes and characteristics.

C. Piping to bear the manufacturer's name, schedule of thickness, size and ASTM identification number

D. Provide valve tag on every valve and control device in each piping system. Exclude check valves and valves within factory fabricated equipment units. List each tagged valve in valve schedule for each piping system.

E. Drain, Auxiliary Drain and Drum Drips: Provide valve tag on every valve in each fire suppression system. List each tagged valve and its location in valve schedule, identify on fire suppression drawings.

F. Install framed, glass or rigid transparent plastic covered, mounted valve schedule and valve location drawing in main riser or fire pump room.

G. Provide identification sign on ceiling tile below valve location.

H. Provide permanent identification sign at pressure regulating valves stating required setting of pressure regulator.

I. Adjusting: Relocate fire suppression identification device which has become visually blocked.

J. Cleaning: Clean face of identification devices and glass frames of valve charts.

3.23 SIGNS

A. General Information Signs: Provide a general information sign used to determine system design basis and information relevant to the inspection, testing and maintenance requirements required by NFPA 25, Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems. Such general information is to be provided with a permanently marked weatherproof metal or rigid plastic sign, secured with corrosion-resistant wire, chain, or other acceptable means. Such signs are to be placed at each system control rise loop and auxiliary system control valve. The sign is to include the following information:
1. Name and Location of the Facility Protected
2. Flow Test Data
3. Location of Auxiliary Drains and Low Point Drains
4. Original Results of Main Drain Flow Test
5. Name of Installing Contractor or Designer

6. Indication of presence and location of other auxiliary systems.

B. Dry Signs: At system riser supplying dry systems, provide the following information: volume in gallons contained in each system.

3.24 DRAINS

A. Locate drain connections within 7-feet of floor. Provide piping capable of being fully drained.

B. Provide a drain vent at top of vertical drains. Coordinate with Division 22, Plumbing.

3.25 SYSTEM IMPAIRMENT

A. When returning a water-based fire protection system to service after impairment or control valve closure, verify the system is in working order by performing a main drain test per NFPA 25.

3.26 PIPE AND PIPE FITTINGS

A. Expansion and Flexibility: Install work with due regard for expansion and contraction to prevent damage to the piping, equipment, building and its contents. Provide piping offsets, loops, approved type expansion joints, sway bracing, wire restraints, vertical restraints, flexible couplings or other means to control pipe movement and to minimize pipe forces.

B. Install piping in concealed spaces above finished ceilings.

C. In open-to-structure areas which are open to public view, route exposed piping to minimize visual impact. Obtain Architect's and Engineer's approval of exposed piping installation.

D. Coordinate support of pipe 4-inches and larger with Structural Engineer.

E. Provide clearances around piping per NFPA 13.

F. Coordinate installation with other trades. Route piping as required to avoid building structure, equipment, plumbing piping, HVAC piping, ductwork, lighting fixtures, electrical conduits and bus ducts and similar work. Final location of lighting will have priority over final sprinkler locations. Provide drains to trapped Sections of system which result from such routing. Other trades take precedence for installation space.

G. General Electrical Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms and other electrical or electronic equipment spaces and enclosures. Within equipment rooms, provide minimum 3-feet lateral clearance from sides of electric switchgear panels. Do not route piping above electric power or lighting panel, switchgear, or similar electric device. Coordinate with electrical and coordinate exact pipe routing to provide proper clearance with such Item.

3.27 BURIED PIPE

A. Hydraulically calculated pipe to be of sufficient size as to deliver the required flow while not exceeding a flow velocity of 15-feet per second or as required in accordance with the water department requirements, whichever is less.

B. Excavation and Backfill:
   1. General: Perform necessary excavation and backfill required for installation of mechanical work. Repair piping or other work damaged by Contractor's operations.
   2. Water: Keep excavations free of standing water. Reexcavate and fill back excavations damaged or softened by water or frost to original level with sand, crushed rock or other approved material at no expense to Owner.
   3. Tests: During progress of work for compacted fill, Owner reserves right to request compaction tests made under direction of a testing laboratory.
   4. Trench Excavation: Excavate trenches to necessary depth and width, removing rocks, unstable soil (i.e. muck, peat and the like), roots and stumps. Excavation material is classified as "base fill" and "native." Base fill excavation material consisting of placed crushed rock may be used as backfill above "Pipe Zone." Remove and dispose off site native excavation material at no expense to Owner. Adequate width of trench for proper installation of piping or conduit.
   5. Support Foundations:

a. Foundations: Excavate trenches located in unstable ground areas below elevation required for installation of piping to a depth which is determined by Architect as appropriate for conditions encountered. Place and compact approved foundation material in excavation up to "Bedding Zone." Dewatering, placement, compaction and disposal of excavated materials to conform to requirements contained in other Sections of Specifications or Drawings.
b. Over-Excavations: Where trench excavation exceeds required depths, provide, place and compact suitable bedding material to proper grade or elevation at no additional cost to Owner.
c. Foundation Material: Where native material has been removed, place and compact necessary foundation material to form a base for replacement of required thickness of bedding material.
d. Bedding Material: Full bed site piping on sand, pea gravel or 3/4-inch minus crushed rock. Place a minimum 4-inch deep layer of sand or crushed rock on leveled trench bottom for this purpose. Remove bedding to necessary depth for piping bells and couplings to maintain contact of pipe on bedding for its entire length. Provide additional bedding in excessively wet, unstable, or solid rock trench bottom conditions as required to provide a firm foundation.

6. Backfilling:
   a. Following installation and successful completion of required tests, backfill piping in lifts.
      1) In "Pipe Zone," place backfill material and compact in lifts not to exceed 6-inches in depth to a height of 12-inches above top of pipe. Place backfill material to obtain contact with entire periphery of pipe, without disturbing or displacing pipe.
      2) Place and compact backfill above "Pipe Zone" in layers not to exceed 12-inches in depth.
   b. Backfill Material:
      1) Backfill Material in "Pipe Zone": 3/4-inch minus crushed rock, sand or pea gravel.
      2) Crushed rock, fill sand or other backfill material approved elsewhere in Specifications may be used above "Pipe Zone."
7. Compaction of Trench Backfill:
   a. Where compaction of trench backfill material is required, use one of following methods or combination thereof:
      1) Mechanical tamper,
      2) Vibratory compacter, or
      3) Other approved methods appropriate to conditions encountered.
   b. Architect to have right to change methods and limits to better accommodate field conditions. Compaction sufficient to attain 95 percent of maximum density at optimum moisture content unless noted otherwise on Drawings or elsewhere in Specifications. Water "puddling" or "washing" is prohibited.

END OF SECTION

SECTION 21 1300
FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Inspector's Test Connections
   2. Floor Control Valve and Test Assembly
   3. Sprinklers
   4. High/Low Pressure Alarm Switch
   5. Air Compressor
   6. Pressure Switch
   7. Dry-Pipe Valve
   8. Hose Valves at Stage

B. This is a contractor designed system. Contact AHJ prior to bid to verify fire system requirements. Provide design compliant with codes as interpreted by AHJ.

C. Scope:
   1. Wet-Pipe Sprinkler System.
   2. Sprinkler protection for areas subject to 40 degrees F and lower: Dry-pipe sprinkler system, dry sprinklers in areas subject to 40 degrees F or less.
   3. Private fire service main from a location 5-feet outside the building. Coordinate location of fire main with civil utility plans to the inlet connection inside the building. Provide required valves and appurtenances.
   4. Provide 2-1/2-inch hose valves at stage. Valves to be supplied by overhead sprinkler system at system pressure.

D. Coordinate location and type of tamper, flow and pressure switches and fire alarm system.

E. Provide electrical connections and wiring as required for a complete and operable system. Includes but is not limited to air compressors, sump pumps and electric bells.

1.02 RELATED SECTIONS

A. Contents of Division 21, Fire Suppression and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
   1. Section 21 00 00, Fire Suppression Basic Requirements
   2. Section 21 05 00, Common Work Results for Fire Suppression

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.07 SYSTEM DESCRIPTION

A. Provide coverage for entire building. Field verify field conditions prior to submittal of bid. Adjust bid to provide protection features in accordance with applicable codes and interpretations by

AHJ. Provide design and installation based on more stringent requirements if AHJ requirements differ from Code.

B. Design Parameters:
   1. Increase remote design area for dry systems, preaction systems, sloped roofs, and concealed areas per NFPA 13.
   2. Building Areas: Offices, Cafeteria, Classrooms.
      a. Occupancy Classification: Light.
      b. Inside Hose Allowance: 0 GPM.
      c. Outside Hose Allowance: 100 GPM.
   3. Building Areas: Mechanical Room, Electrical Room, Boiler Room.
      a. Occupancy Classification: Ordinary Group 1.
      b. Inside Hose Allowance: 0 GPM.
      c. Outside Hose Allowance: 250 GPM.
   4. Building Areas: Platform, Storage Rooms.
      a. Occupancy Classification: Ordinary Group 2.
      b. Inside Hose Allowance: 0 GPM.
      c. Outside Hose Allowance: 250 GPM.
   5. Design parameters above are NFPA 13 minimums. Provide increased design densities, design areas and hose allowances to meet requirements of AHJ.

C. Sprinkler system design to include a 10 percent pressure and flow cushion between system demand point and available water supplies.

D. Extend hydraulic calculations from hydraulically most remote design area back to location of pressure hydrant of flow test or effective point of water supply where characteristics of water supply are known.

E. Develop cost-effective designs that may include use of extended coverage sprinklers and design area reductions as allowed by NFPA 13.

1.08 EXTRA STOCK

A. Provide extra sprinklers per code; provide suitable wrenches for each sprinkler type and metal storage cabinet in riser room. Inside the cabinet, provide a list of sprinklers installed in the property, including sprinkler identification number, manufacturer, model, orifice, deflector type, thermal sensitivity and pressure rating, quantity of each type to be contained in the cabinet and issue or revision date of the list.

1.09 CONTROL VALVES

A. Sprinkler system control valves to be post indicator valves located minimum of 40-feet from building.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Inspector's Test Connections:
   1. AGF TestAnDrain
   2. Or approved equivalent.

B. Floor Control Valves and Test Assembly:
   1. Viking
   2. Tyco
   3. Victaulic
   4. Or approved equivalent.

C. Sprinklers:
   1. Finished Areas:
      a. Viking
      b. Tyco
      c. Reliable
      d. Victaulic

e. Globe
f. Or approved equivalent.

2. Nonfinished Areas:
a. Viking
b. Tyco
c. Reliable
d. Victaulic
e. Globe
f. Or approved equivalent.

3. Dry Sprinklers:
a. Viking
b. Tyco
c. Reliable
d. Victaulic
e. Or approved equivalent.

D. High/Low Pressure Alarm Switch:
1. Potter
2. System Sensor
3. Or approved equivalent.

E. Air Compressor:
1. General
2. Or approved equivalent.

F. Pressure Switch:
1. Potter
2. Or approved equivalent.

G. Dry-Pipe Valve:
1. Viking
2. Tyco
3. Victaulic
4. Or approved equivalent.

H. Hose Valve:
1. Potter Roemer
2. Guardian Fire

2.02 INSPECTOR'S TEST CONNECTIONS

A. Bronze, tamper and corrosion resistant orifice equivalent to smallest sprinkler orifice.

B. Sight flow connection.

2.03 FLOOR CONTROL VALVE AND TEST ASSEMBLY

A. Control valve, water-flow alarm, sight glass, smooth bore orifice union of same size as smallest orifice sprinkler installed.

B. Manufacturer: Viking, Tyco 513, Victaulic 747/747P.

2.04 SPRINKLERS

A. Finished Areas:
1. ACT and GWB Ceilings:
a. Type: Glass-Bulb
b. Style: Recessed
c. Response: Quick-Response
d. Finish: White Polyester
e. Escutcheon: White Polyester

2. Wood Deck/Exposed to Structure:
a. Type: Glass-Bulb

b. Response: Quick-Response
c. Finish: Chrome
d. Escutcheon: None

B. Nonfinished Areas: Utility Rooms (Mechanical, Electrical, Janitorial and Storage).
1. Type: Glass-Bulb
2. Response: Quick-Response
3. Finish: Brass

C. Dry Sprinklers:
1. Type: Glass-Bulb
2. Style: Recessed
3. Response: Quick-Response
4. Finish: White Polyester
5. Escutcheon: White Polyester

2.05 HIGH/LOW PRESSURE ALARM SWITCH

A. Pressure actuated to detect 10 PSI increase or decrease; SPDT switches.

B. Manufacturer: Potter PS40A, System Sensor.

2.06 AIR COMPRESSOR

A. Manufactured for fire sprinkler systems.

B. Tank mounted with automatic drain valve and compatible air maintenance device.

C. Riser mounted is not acceptable.

D. UL Listed pressure switch.

E. Air pressure gauge.

F. Neoprene and cork vibration isolation pads with stainless steel flex hose.

G. Tank to be provided with a 1/2-inch minimum outlet for air supply.

2.07 PRESSURE SWITCH

A. Pressure actuated; SPDT switches.

B. Manufacturer: Potter PS10.

2.08 DRY-PIPE VALVE

A. Differential or low pressure actuator type.

B. Trim as recommended by manufacturer for variable pressure service, including air maintenance device, electric low pressure alarm switch, priming valves and test, main drain and pressure gauges.

C. Manufacturers: Viking G-4000, Tyco DPV-1, or Victaulic FireLock NXT.

2.09 HOSE VALVE

A. 2-1/2-inch hose valve equipped with 1-1/2-inch reducer, and cap and chain of same material.

PART 3 - EXECUTION

3.01 GENERAL

A. Coordinate location of auxiliary drains with Architect. Architect to approve location before drain is installed. Protect valves from tampering or accidental operation.

3.02 PIPE AND FITTINGS

A. Route fire main from riser room to Zone A of the school in the underground utility corridor in order to avoid having large diameter supply mains in rooms 101, 120, 121 and S120.

B. Install piping in concealed spaces above finished ceilings. Prior to design and installation obtain preapproval by Architect and Engineer for exposed piping.

C. Install piping as close as possible to ceiling to avoid conflicts with other trades.

D. Install pipe runs to minimize obstruction to other work.

E. Pitch pipe for dry system piping located or passing through warm as well as cold areas.

F. Mount dry system drum drips a minimum of 7-feet above floor.

G. Install dry sprinklers in a manner which does not trap water.

3.03 INSPECTOR'S TEST CONNECTIONS

A. Locate where full flow discharge will not do damage, including damage to landscaping.

B. Locate within 5-feet of finished floor.

3.04 FLOOR CONTROL VALVE AND TEST ASSEMBLY

A. Locate in an area so as to minimize visual impact.

B. Provide connection to drain.

C. Pipe pressure relief valve to drain.

3.05 SPRINKLERS

A. Center sprinklers in center or quarter points of suspended ceiling tile.

B. Align sprinklers with architectural column lines, lighting, diffusers and other ceiling features. In unfinished ceilings, route piping to minimize visual impact. Sprinklers and piping not so aligned are to be removed and replaced at no additional cost to Owner.

C. Provide listed flexible sprinkler hose assembly for pendent sprinkler heads installed in acoustic ceiling tiles.

3.06 HIGH/LOW PRESSURE ALARM SWITCH

A. Coordinate with Division 28, Electronic Safety and Security.

3.07 AIR COMPRESSOR

A. Provide air compressor sized to fill system and to maintain system pressure as required per Code.

B. Pipe fluid discharge automatic tank reservoir to sanitary sewer, with air gap.

C. Locate in an area between 40 degrees F and 110 degrees F.

D. Provide 12- to 18-inches clearance from walls or other obstructions that will interfere with airflow through the motors fan building into the motor. Protect from excessive heat, such as near a boiler.

E. Provide a flexible hose between the compressor and service piping when vibration isolators are used.

3.08 PRESSURE SWITCH

A. Coordinate with Division 28, Electronic Safety and Security.

3.09 DRY PIPE VALVE

A. Install with sufficient access for ease of reset.

3.10 HOSE VALVE

A. Install on each side of stage with sufficient room for operation of hose valve.

END OF SECTION

SECTION 22 0000
PLUMBING BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work included in 22 00 00, Plumbing Basic Requirements applies to Division 22, Plumbing work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of plumbing systems for proposed project.

B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.

C. Definitions:
   1. Provide: To furnish and install, complete and ready for intended use.
   2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
   3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work furnished.
   4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent", substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
   5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.02 RELATED SECTIONS:

A. Contents of Section applies to Division 22, Plumbing Contract Documents.

B. Related Work:
   1. Additional conditions apply to this Division including, but not limited to:
      a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. 01 33 00 Delegated Design Requirements: administrative and procedural requirements for Subcontractor Bidder-Engineered items.
      b. Drawings
      c. Addenda
      d. Owner/Architect Agreement
      e. Owner/Contractor Agreement
      f. Codes, Standards, Public Ordinances and Permits

C. Related products/systems located in Division 23, HVAC:
   1. Section 23 11 23 - Facility Fuel - Natural Gas Piping and Systems

1.03 REFERENCES AND STANDARDS

A. References and Standards per Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, individual Division 22, Plumbing Sections and those listed in this Section.

B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
   1. State of Oregon:
      a. OAR Oregon Administrative Rules
      b. OESC Oregon Electrical Specialty Code
      c. OFC Oregon Fire Code

d. OMSC Oregon Mechanical Specialty Code
e. OPSC Oregon Plumbing Specialty Code
f. OSSC Oregon Structural Specialty Code
g. OEESC Oregon Energy Efficiency Specialty Code
h. Oregon Elevator Specialty Code

C. General: Reference standards and guidelines include but are not limited to the latest adopted editions from:
1. ABA Architectural Barriers Act
2. ADA Americans with Disabilities Act
3. AHRI Air-Conditioning Heating & Refrigeration Institute
4. ANSI American National Standards Institute
5. ASCE American Society of Civil Engineers
6. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers
7. ASHRAE Guideline 0, the Commissioning Process
8. ASME American Society of Mechanical Engineers
9. ASPE American Society of Plumbing Engineers
10. ASSE American Society of Sanitary Engineering
11. ASTM ASTM International
12. AWWA American Water Works Association
13. CFR Code of Federal Regulations
14. CGA Canadian Gas Association
15. CISPI Cast Iron Soil Pipe Institute
16. CSA CSA International
17. ETL Electrical Testing Laboratories
18. EPA Environmental Protection Agency
19. FDA Food & Drug Administration
20. FM FM Global
21. IAPMO International Association of Plumbing and Mechanical Officials
22. GAMA Gas Appliance Manufacturers Association
23. HI Hydraulic Institute Standards
24. ISO International Organization for Standardization
25. LEED Leadership in Energy and Environmental Design
26. MSS Manufacturers Standardization Society
27. NEC National Electric Code
28. NEMA National Electrical Manufacturers Association
29. NFGC National Fuel Gas Code
30. NFPA National Fire Protection Association
31. NRCA National Roofing Contractors Association
32. NSF National Sanitation Foundation
33. OSHA Occupational Safety and Health Administration
34. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
35. TEMA Tubular Exchanger Manufacturers Association
36. TIMA Thermal Insulation Manufacturers Association
37. UL Underwriters Laboratories Inc.
38. USDA United States Department of Agriculture

D. See Division 22, Plumbing individual Sections for additional references.

E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.

F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

G. Piping Insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.04 SUBMITTALS

A. See Division 01, General Requirements for Submittal Procedures and Section 01 3300 Delegated Design Requirements, as well as specific individual Division 22, Plumbing Sections.

B. Camera Inspection: Contractor to pressure-wash the sanitary sewer piping to remain in service. Submit a video recording of the interior of the cleaned waste piping to the District and Engineer for review. Video recording will have footage data included so any defects can be located and repaired.

C. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.

D. In addition:

1. "No Exceptions Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.
3. Product Data: Provide Manufacturer's descriptive literature for products specified in Division 22, Plumbing Sections.
4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the Specifications and Drawings.
    a. Label submittal to match numbering/references as shown in Contract Documents and schedules. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
    b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference Division 22, Plumbing Sections for specific items required in product data submittal outside of these requirements.
    c. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.
    d. For vibration isolation of equipment, list make and model selected with operating load and deflection. Indicate frame type where required. Submit manufacturer's product data.
    e. See Division 22, Plumbing Sections for additional submittal requirements outside of these requirements.
5. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of additional reviews at Engineer's

hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.

6. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet Section 22 0548, Vibration and Seismic Controls for Plumbing Piping and Equipment. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Part 3 of this Section.
7. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 22, Plumbing Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.
8. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
9. Substitutions and Variation from Basis of Design:
    a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
    b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.
10. Shop Drawings: Provide coordinated Shop Drawings which include physical characteristics of all systems, equipment and piping layout plans, and control wiring diagrams. Reference individual Division 22, Plumbing Sections for additional requirements for Shop Drawings outside of these requirements.
    a. Provide Shop Drawings indicating sanitary and storm cleanout locations and type to Architect for approval prior to installation.
    b. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
11. Samples: Provide samples when requested by individual Sections.
12. Resubmission Requirements:
    a. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
        1) Resubmit for review until review indicates no exceptions taken or "make corrections as noted".
        2) When submitting drawings for Engineers re-review, clearly indicate changes on drawings and "cloud" any revisions. Submit a list describing each change.
13. Operation and Maintenance Manuals, Owners Instructions:
    a. Submit, at one time, electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Include valve charts. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.

1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment: belts, motors, lubricants, and filters.
3) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.
4) Include copy of startup and test reports specific to each piece of equipment.
5) Include copy of final water systems balancing log along with pump operating data.
6) Include commissioning reports.
7) Include copy of pressure, flow, leakage and purity test data and air and water systems test data, as applicable. Include copy of third-party and state and local jurisdiction inspection reports.
8) Include copy of valve charts/schedules.
9) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
10) Include product certificates of warranties and guarantees.
11) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.

b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 22 00 00, Plumbing Basic Requirements article titled "Demonstration".
c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

14. Record Drawings:
a. Maintain at site at least one set of drawings for recording “As-constructed” conditions. Indicate on Drawings changes to original documents by referencing revision document, and include buried elements, location of cleanouts, and location of concealed mechanical items. Include items changed by field orders, supplemental instructions, and constructed conditions.
b. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.
c. At completion of project, input changes to original project on Revit Model and make one set of black-line drawings created from Revit Model in version/release equal to contract drawings. Submit Revit disk and drawings upon substantial completion.
d. Provide Invert elevations and dimensioned locations for water services, building waste, and storm drainage piping below grade extending to 5-feet outside building line.
e. See Division 22, Plumbing individual Sections for additional items to include in record drawings.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements: Work and materials installed to conform with all local, State, Federal and other applicable laws and regulations.

B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturers equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.

C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.

D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.

E. UL and CSA Compliance: Provide products which are UL listed.

F. ASME Compliance: ASME listed water heaters and boilers with an input of 200,000 BTUH and higher, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.

G. Provide safety controls required by National Boiler Code (ASME CSD 1) for boilers and water heaters with an input of 400,000 BTUH and higher.

1.06 WARRANTY

A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Contracting and Procurement Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty in Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.07 COORDINATION DOCUMENTS

A. Prior to construction, prepare and submit coordinated layout drawings (composite drawings) to coordinate installation and location of ductwork, grilles, diffusers, piping, fire sprinklers, plumbing, lights, and electrical services. Composite Drawings show services on single sheet. Key Drawings to structural column identification system. Prior to completion of Drawings, coordinate proposed installation with architectural and structural requirements, and other trades (including plumbing, HVAC, fire protection, electrical, ceiling suspension, and ceiling tile systems, etc.), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence. Unless otherwise required by Division 00, Procurement and Contracting Requirements and/or Division 01, General Requirements, Division 23, HVAC to combine information furnished by other trades onto master coordination documents.

B. Prepare Drawings as follows:
   1. Drawings in Revit Model. Revit Model release equal to design documents. Drawings to be same sheet size and scale as Contract Drawings and indicate location, size and elevation above finished floor of equipment and distribution systems.
   2. Review and revise, as necessary, Section cuts in Contract Drawings after verification of field conditions.
   3. Indicate plumbing system piping including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
   4. Indicate inverts and provision for piping that must be graded to have right-of-way over more flexible items. Drawings also to indicate proposed ceiling grid and lighting layout as shown on electrical drawings and architectural reflected ceiling drawings and HVAC equipment, ductwork and piping.

5. Incorporate Addenda items and change orders.
6. Distribute drawings to trades and provide additional coordination as requested by other trades.

C. Advise Architect in event conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.

D. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.

E. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide like items from one manufacturer, including but not limited to fixtures, pumps, drains and equipment.

2.02 MATERIALS

A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL approved or have adequate approval or be acceptable by State, County, and City authorities.

B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.

C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

D. Hazardous Materials:
1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.03 ACCESS PANELS

A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.

B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 22, Plumbing Sections. In the absence of specific requirements, comply with the following:
1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
    a. Ceiling access panels to be minimum 24-inch by 24-inch required and approved size.
    b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
    c. Provide screwdriver operated catch.
    d. Manufacturers and Models:
        1) Drywall: Karp KDW.
        2) Plaster: Karp DSC-214PL.
        3) Masonry: Karp DSC-214M.
        4) 2 hour rated: Karp KPF-350FR.
        5) Milcor, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.01 ACCESSIBILITY AND INSTALLATION

A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

B. Install equipment requiring access (i.e., drain pans, drains, control operators, valves, motors, cleanouts and water heaters) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.

C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines.

D. Earthwork:
   1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
      a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with the provisions of related earthwork Sections/divisions. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
      b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
      c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.

E. Firestopping:
   1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
      a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

F. Pipe Installation:
   1. Coordinate work to account for expansion and contraction of piping materials and building as well as anticipated settlement or shrinkage of building. Install work to prevent damage to piping, equipment, and building and its contents. Provide piping offsets, loops, expansion joints, sleeves, anchors or other means to control pipe movement and minimize forces on piping. Verify anticipated settlement and/or shrinkage of building. Verify construction phasing, type of building construction products and rating for coordinating installation of piping systems.
   2. Include provisions for servicing and removal of equipment without dismantling piping.

G. Plenums:
   1. Provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.

H. Utility Tunnels:
   1. Contractor will coordinate with other trades for services installed within the utility tunnels. Service piping shall be installed such as to maintain a clear passage for a repairman to move and work inside the tunnels.

a. A 24-inch cross-sectional area will be provided along all portions of the tunnel for service access. This area shall extend from the bottom to top of the tunnel.
b. The floor shall be maintained clear from any pipe installations. Should piping be proposed for the service access area, it will be submitted as a shop drawing for review and acceptance prior to pipe installation.
c. The utility tunnels will be left clean with no construction debris.

3.02 SEISMIC CONTROL

A. Confirm Seismic Control requirements in Division 01, General Requirements, Section 22 0548, Vibration and Seismic Controls for Plumbing Piping and Equipment, Section 22 00 00, Plumbing Basic Requirements and individual Division 22 Plumbing Sections.

B. Equipment Importance Factor: 1.0.

C. General:
1. Confirm Building Occupancy Category and Seismic Design Category with Structural Engineer.
2. Earthquake resistant designs for Plumbing (Division 22, Plumbing) equipment and distribution, i.e. motors, plumbing systems, piping, equipment, water heaters, boilers, etc. conform to regulations of jurisdiction having authority.
3. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
4. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for piping equipment and water heaters. Submit Shop Drawings along with equipment submittals.
5. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details. Coordinate exact design requirements with project Structural Engineer.

D. Piping:
1. Per "Seismic Restraints Manual Guidelines for Mechanical Systems" latest edition published by SMACNA or local requirements.

E. Equipment:
1. Provide means to prohibit excessive motion of plumbing equipment during earthquake.

3.03 REVIEW AND OBSERVATION

A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
1. Underground piping installation prior to backfilling.
2. Prior to covering walls.
3. Prior to ceiling cover/installation.
4. When main systems, or portions of, are being tested and ready for inspection by AHJ.

C. Bear responsibility and cost to make piping accessible, to expose concealed lines, or to demonstrate acceptability of the system. If Contractor fails to notify Architect at times prescribed above, costs incurred by removal of such work are the responsibility of the Contractor.

D. Final Punch:
1. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.04 CONTINUITY OF SERVICE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
   1. During remodeling or addition to existing structures, while existing structure is occupied, current services to remain intact until new construction, facilities or equipment is installed.
   2. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new piping, and wiring to point of connection.
   3. Coordinate transfer time to new service with Owner. If required, perform transfer during off peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
      a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
   4. Organize work to minimize duration of power interruption.

3.05 CUTTING AND PATCHING

A. Confirm Cutting and Patching requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
   1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
   2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
   3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
   4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing piping and devices are removed as part of this project. Where alterations disturb lawns, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
   5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.06 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

3.07 DELIVERY, STORAGE AND HANDLING

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
   1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced before installation. Products and/or materials that become damaged due to water, dirt and/or dust as a result of improper storage to be replaced before installation.
   2. Protect equipment and pipe to avoid damage. Close pipe openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.

3. Protect bright finished shafts, bearing housings and similar items until in service.

3.08 DEMONSTRATION

A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.09 CLEANING

A. Confirm cleaning requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

B. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.10 INSTALLATION

A. Confirm installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Do not place equipment in sustained operation prior to initial balancing of plumbing systems.
   2. Provide pump impellers to obtain Basis of Design design capacities.

D. Provide miscellaneous supports/metals required for installation of equipment and piping.

3.11 PAINTING

A. Confirm requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
   1. Ferrous Metal: After completion of plumbing work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces, i.e., hangers, hanger rods, equipment stands, with one coat of black asphalt for exterior or black enamel for interior, suitable for hot surfaces.
   2. In a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
   3. See individual equipment Specifications for other painting.
   4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.

5. Piping: Clean, primer coat and paint exposed piping on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.
6. Covers: Covers such as manholes, cleanouts and the like will be furnished with finishes which resist corrosion and rust.

3.12 ACCESS PANELS

A. Confirm Access Panel requirements in Division 01, General Requirements. In absence of specific requirements in Division 01, General Requirements, comply with individual Division 22, Plumbing Sections and the following:
   1. Coordinate locations/sizes of access panels with Architect prior to work. Label access panels with engraved nameplates indicating function of panel.

3.13 DEMOLITION

A. Confirm Demolition requirements in Division 01, General Requirements and Division 0. In absence of specific requirements, comply with individual Sections in Division 22, Plumbing and the following:
   1. Scope:
      a. It is the intent of these documents to provide necessary information and adjustments to plumbing system required to meet code, and accommodate installation of new work.
      b. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
      c. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
   2. Equipment: Unless otherwise directed, equipment, fixtures, or fittings being removed as part of demolition process are Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.
   3. Unless specifically indicated on Drawings, remove exposed, unused piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap piping and patch surfaces to match surrounding finish.
   4. Unless specifically indicated on Drawings, remove unused equipment, fixtures, fittings, rough-ins, and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).

3.14 ACCEPTANCE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Sections in Division 22, Plumbing and the following:
   1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
      a. Testing and Balancing Reports
      b. Cleaning
      c. Operation and Maintenance Manuals
      d. Training of Operating Personnel
      e. Record Drawings
      f. Warranty and Guaranty Certificates
      g. Start-up/Test Document and Commissioning Reports

3.15 FIELD QUALITY CONTROL

A. Confirm Field Quality Control requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

B. Tests:
   1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in operation and maintenance manuals.
   2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.16 LETTER OF CONFORMANCE

A. Provide Letter of Conformance, copies of manufacturers' warranties and extended warranties with a statement that plumbing items were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include Letter of Conformance, copies of manufacturers' warranties and extended warranties in Operation and Maintenance Manuals.

3.17 ELECTRICAL INTERLOCKS

A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize plumbing equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.

END OF SECTION

SECTION 22 0513

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. General
   2. General Motor Construction and Requirements
   3. Low Voltage Control Wiring
   4. Control Cable
   5. Applications
   6. Starters
   7. Disconnects

1.02 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.03 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements apply to this Section.

B. In addition, meet the following:
   1. Field Installed Motors: Installed motors to be of single type, from one source and from a single manufacturer.

1.04 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Motors:
   1. Lincoln Motors
   2. A.O. Smith Electrical Products
   3. Baldor Electric (Reliance Electric)
   4. General Electric
   5. Toshiba
   6. Exceptions: Motors integral to equipment efficiency listing (EER, COP, etc.) per listing agency.
   7. Or approved equivalent.

B. Low Voltage Control Wiring:
   1. General Electric
   2. Anaconda
   3. Rome
   4. Or approved equivalent.

2.02 GENERAL

A. Electrical components and materials to be UL to ETL listed/labeled as suitable for location and use.

B. Wiring installed in conduit.

2.03 GENERAL MOTOR CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: Power wiring from source to motor termination under Division 26, Electrical. Coordinate location of disconnect and starter or motor controller. Combination starter/disconnects may be used in lieu of separate items.

B. Electrical Service - Unless otherwise noted in the Contract Documents, the following voltage and phase characteristics apply to motors:
   1. Motors 1/2 HP and Under: 120 volt, 1 phase.
   2. Motors 3/4 HP and Over: 208 volt, 3 phase.
   3. Motors 3/4 HP and Over: 480 volt, 3 phase

C. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 104 Degrees F environment.
   3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
   4. Built-in thermal overload protection or externally protected with separate over-load with low-voltage release or lock-out. Quick trip device on hermetically sealed motors.
   5. Service Factor: 1.15 for poly-phase motors. 1.25 for motors associated with shaft pressurization system fans. 1.35 for single phase motors.
   6. Noise Rating: Quiet.
   7. Efficiency: Provide premium efficiency motors.
   8. Motors used in Conjunction with Variable Speed Drives: Variable torque type matched for the full operating range of the variable frequency drive. As a minimum, motors to have Class F insulation, winding insulation rated for 1000 volts and insulated bearings to prevent high frequency ground path. Loads not-to-exceed 80 percent of nameplate rating

D. Explosion-Proof Motors: UL approved and labelled for hazard classification with over temperature protection.

E. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

F. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Coordinate conductor sizes with Division 26, Electrical. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

G. Provide inverter ready motors per NEMA MG1-30 for variable speed drive or soft-start starter use. Provide shaft grounding for motors over 2 HP serving variable speed drives. Provide shaft grounding and insulated bearings on motors 25 HP and larger serving variable speed drives. Shielded cable required for power wiring from variable speed drive to motor connection.

H. Unless otherwise indicated, motors 1-HP and larger to meet/exceed NEMA Premium Efficiency and latest EPACT.

I. Vertical in-line pump motors per NEMA MG1, Motors and Generators.

2.04 LOW VOLTAGE CONTROL WIRING

A. General 60 Hz Control Circuiting: 600 volts insulated 14 gauge, Type THHN, color coded, installed in conduit in mechanical rooms and exposed locations. In other areas, plenum rated cable is allowed. Reference Division 26, Electrical Specifications for details of wiring and conduit.

2.05 CONTROL CABLE

A. Wire: Multiple pair, No. 18 gauge minimum conductor size cable with an abrasion and damage resilient outer jacket suitable for exposed installation, cable to be UL approved at 250 or labeled 300 volt insulated and conform with codes, ordinances, rules and standards applicable.

B. Wire Supports for Wiring Installed Without Raceways: Nylon cable ties, bridle rings or cable clip with metal or plastic base plates applied to structure with construction adhesive or mastic; dedicated support wires attached from the structure members.

C. Cabling for VFD's: Provide shielded cable for power wiring from VFD to motor. UL 1277, Type TC-ER cable. Houston Wiring, Belden or approved equivalent.

2.06 APPLICATIONS

A. Exception: Motors less than 250 watts, for intermittent service, motors furnished with equipment manufacturer's standard package equipment need not conform to these Specifications.

B. Single Phase Motors for Air Compressors and Pumps: Capacitor start type.

C. Motors located in exterior locations or wet air streams are to be of totally enclosed type.

D. Motors Located Wet/Wash-Down Locations: Totally enclosed weatherproof epoxy-sealed type.

2.07 STARTERS

A. Single-Phase Motors:
   1. Manual across-the-line starting switch having toggle-operated switch pilot running light and built-in thermal overload device with heating element rated not more than 115 percent motor full load current indicated on name plate of motor to be protected. Surface mount starters. Provide NEMA-1 enclosure.
   2. Overload relays to be melting alloy type with a replaceable control circuit module. Thermal units to be interchangeable. Starter to be non operative if thermal unit is removed.
   3. Single-phase motors with automatic controls. Provide motor-rated relay with coils rated for control voltage.

B. Starters up to Size 8 to be suitable for the addition of a minimum of three external auxiliary contacts (normally open or normally closed). Contactor, coils, and relays to perform the control functions of the associated equipment and control sequence.

C. 3-Phase Motors up to and Including 15 HP:
   1. Provide enclosed type magnetic across-the-line starter with thermal overload and undervoltage protection.
   2. Operator: "Start-Stop" pushbutton, except where automatic control is indicated on Drawings or specified. Then provide "Hand-Off-Auto" selector switch.
   3. Starters for 3-phase motors to have overload protection in each of the three legs, with external manual reset.
   4. Unless indicated on Drawings or in Specifications, furnish motor starters with a neon pilot light. Neon lights are required for exhaust fan switches.
   5. Equip starters with integral transformer and coil for control circuit. Coordinate coil voltage with control voltage.

2.08 DISCONNECTS

A. Provided by Division 26, Electrical unless specified otherwise.

PART 3 - EXECUTION

3.01 ELECTRICAL REQUIREMENTS

A. Contractor to Provide the Following Where Applicable:
   1. Motors
   2. Starters and disconnects if they are integral parts of mechanical equipment as shown on the equipment schedules. Reference Drawings and subsequent Sections.
   3. Low Voltage and Electronic Control Devices
   4. Low Voltage Transformers
   5. Low Voltage Conduit and Wire and Connecting Devices
   6. Conduit and wire for electronic devices, except for line voltage wiring.
   7. Heat Tracing Devices

B. Electrical work listed above performed by a licensed electrical contractor or by the control manufacturer, but provided for and coordinated under Division 22, Plumbing work. In addition, controls work supervised and subsequently approved in writing by the control manufacturer.

C. Contractor to furnish the following to the Electrical Contractor where applicable: Line voltage control equipment, including switches (except disconnects), time switches, transformers, relays, etc. (except those part of MCC).

D. Include the Following Items under Division 26, Electrical Work:
   1. Line voltage wire and conduit system.
   2. Starters and disconnects not provided with equipment.
   3. Installation of line voltage control equipment furnished under Paragraph 3.01.C.above.

3.02 CONTROL CABLE INSTALLATION

A. Install low voltage control cable exposed in areas without suspended ceilings, buried in room partition walls and hidden above suspended ceilings. Install exposed wiring in a neat manner with wiring runs laid out parallel to building walls and support horizontal runs to eliminate sagging loops between support rings and clips. Tie cable running parallel to electrical conduit to the electrical conduit with nylon cable ties where conduit is nearby. In areas where conduit is not available, attach cable to the concrete structure with bridle rings or cable clips attached with mastic. Above suspended ceilings support the cable with bridle rings hung from ceiling support wires with caddy attachments. Install each change in direction of exposed cable installed with a single 90 degree angle turn.

3.03 ELECTRICAL INTERLOCKS

A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize mechanical equipment wiring diagrams to coordinate with the electrical systems so that proper wiring of the equipment involved is affected.

3.04 MOTOR INSTALLATION

A. Install in accordance with manufacturer's instructions. Coordinate with starter or variable speed controller with control sequence to provide necessary starter accessories.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

D. Verify motor rotation.

3.05 FIELD QUALITY CONTROL

A. Prepare for Acceptance Tests as Follows:
   1. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
   2. Test interlocks and control features for proper operation.
   3. Verify that current in each phase is within nameplate rating.

B. Testing: Perform the Following Field Quality-Control Testing:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect field-assembled components, equipment installation, and piping and electrical connections for compliance with requirements.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Verify bearing lubrication.
   4. Verify proper motor rotation.
   5. Test Reports:
      a. Prepare a written report to record the following test procedures used:
         1) Test results that comply with requirements.

2) Test results that do not comply with requirements and corrective action taken to achieve compliance.

3.06 CONTROLLERS

A. Install enclosed controllers in accordance with manufacturer's instructions.

B. Coordinate disconnect requirements and location with Division 26, Electrical if not integral to controller. If controller is installed out of line of sight of motor, provide additional disconnect at motor per Code.

C. Provide NEMA housing appropriate to installation location.

D. Provide supports and install securely, in neat and workmanlike manner, as specified in NECA 1.

E. Meet mounting height and accessible location requirements per local code.

F. Provide fuses for fusible switches.

G. Select and install overload heater elements in motor controllers to match installed motor characteristics.

H. Provide engraved plastic nameplates.

I. Provide neatly typed label inside each motor controller door identifying motor served, nameplate.

J. Single Phase 120 Volt Starter: If not furnished as single packaged controller/disconnect, provide contactors, relays, wiring and devices necessary to match sequence of operation for equipment.

3.07 ADJUSTING

A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.08 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION

SECTION 22 0516
EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Flexible Pipe Connectors, Copper Piping
   2. Flexible Pipe Connectors - Gas Piping (CSA Approved)
   3. Flexible Expansion Loop (for Thermal and Seismic Applications), Copper Piping
   4. Accessories

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Design Data: Indicate selection calculations.
   2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
   3. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Flexible Pipe Connectors, Copper Piping:
   1. Mercer Rubber Company
   2. Metraflex Company
   3. Mason
   4. Hyspan
   5. Or approved equivalent.

B. Flexible Pipe Connectors - Gas Piping (CSA Approved):
   1. Mercer Rubber Company
   2. Metraflex Company
   3. Mason
   4. Hyspan
   5. Or approved equivalent.

C. Flexible Expansion Loop (for Thermal and Seismic Applications), Copper Piping:
   1. Mercer Rubber Company
   2. Metraflex Company
   3. Mason
   4. Hyspan

5. Or approved equivalent.

D. Accessories
   1. Mercer Rubber Company
   2. Metraflex Company
   3. Mason
   4. Hyspan
   5. Or approved equivalent.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

A. Inner Hose: Bronze, close pitch, annular corrugated hose.

B. Exterior Sleeve: Braided bronze (piping over 2-inches to be 3 pound braided stainless steel).

C. Pressure Rating: 125 PSI at 70 degrees F with a 4 to 1 safety factor.

D. Joint: Sweat ends.

E. Size: Use pipe sized units.

F. Maximum offset: 3/8-inch on each side of installed center line.

G. Basis of Design: Metraflex Model BBS.

2.03 FLEXIBLE PIPE CONNECTORS - GAS PIPING (CSA OR UL APPROVED)

A. Inner Hose: 304 stainless steel.

B. Exterior Sleeve: Braided, 304 stainless steel.

C. Pressure Rating: 175 PSI at 70 degrees F up to 4-inch pipe.

D. Joint: Threaded carbon steel.

E. Maximum Offset: 3/4-inch on each side of installed center line.

F. Basis of Design: Mason CSAMN.

2.04 FLEXIBLE EXPANSION LOOP (FOR THERMAL AND SEISMIC APPLICATIONS) - COPPER PIPING

A. Construction: Two flexible Sections of hose and braid, two 90 degree elbows and a 180 degree return designed so piping does not change direction, but maintains course along a single axis. Use Vee Loop where space is limited. System to import no thrust loads to system support anchors or building structure.

B. Inner Hose: Bronze, close pitch, annular corrugated hose.

C. Exterior Sleeve: Braided bronze.

D. Pressure Rating: 125 PSI at 70 degrees F with a 4 to 1 safety factor.

E. Joint: Sweat ends.

F. Size: Use pipe sized units.

G. Support: Center support at bottom of 180 degree return.

H. Basis of Design: Metraflex Metraloop. Vee configuration Mason-Mercer VCPSB.

2.05 ACCESSORIES

A. Stainless Steel Pipe: ASTM A 269.

B. Pipe Alignment Guides:
   1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1-inch thick insulation, minimum 3-inches travel.

C. Swivel Joints:
   1. Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Expansion Fitting Installation:
   1. Install expansion fittings according to manufacturer's written instructions.
   2. Install expansion fittings in sizes matching pipe size in which they are installed.
   3. Align expansion fittings to avoid end-loading and torsional stress.
   4. Install in accordance with EJMA (Expansion Joint Manufacturer's Association) Standards.

B. Pipe Bend and Loop Installation:
   1. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
   2. Attach pipe bends and loops to anchors.
      a. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code Section IX, "Welding and Brazing Qualifications."
      b. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

C. Swing Connections:
   1. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
   2. Connect mains, risers and branch connections to equipment with at least four pipe fittings, including tee in riser.

D. Guide Installation:
   1. Install guides on piping adjoining expansion fittings and loops.
   2. Attach guides to pipe and secure to building structure.

E. Anchor Installation:
   1. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
   2. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
   3. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.
   4. Install pipe anchors according to expansion fitting manufacturer's written instructions if expansion fittings are indicated.
   5. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

F. Painting:
   1. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA1 requirements for touching up field-painted surfaces.
      a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
   2. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.02 FLEXIBLE PIPE CONNECTORS, COPPER PIPING

A. See General Installation Requirements above.

3.03 FLEXIBLE PIPE CONNECTORS - GAS PIPING (CSA APPROVED)

A. See General Installation Requirements above.

3.04 FLEXIBLE EXPANSION LOOP (FOR THERMAL AND SEISMIC APPLICATIONS), COPPER PIPING

A. See General Installation Requirements above.

3.05 ACCESSORIES

A. See General Installation Requirements above.

END OF SECTION

SECTION 22 0519
PLUMBING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Pressure Gauges
   2. Thermometers
   3. Thermometer Wells
   4. Pressure-Gauge Fittings
   5. Test Plugs
   6. Water Hammer Arrestors (Shock Absorbers)
   7. Trap Primers

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements apply to this Section.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Pressure Gauges:
   1. Dwyer Instruments, Inc.
   2. Moeller Instrument Co., Inc.
   3. Omega Engineering, Inc.
   4. Trerice
   5. Or approved equivalent.

B. Thermometers:
   1. Ashcroft
   2. Trerice
   3. Weiss
   4. Marshaltown
   5. Weksler
   6. Or approved equivalent.

C. Water Hammer Arrestors (Shock Absorbers), Bellows Type:
   1. Amtrol
   2. J.R. Smith
   3. Wade
   4. Zurn
   5. Or approved equivalent.

D. Water Hammer Arrestors (Shock Absorbers), Piston Type:

1. PPP
2. Sioux Chief
3. Or approved equivalent.

E. Trap Primers:
1. Wade
2. Zurn
3. J.R. Smith
4. PPP
5. Or approved equivalent.

2.02 PRESSURE GAUGES

A. Pressure Gauges: ASME B40.100, phosphor-bronze bourdon type, dry type.
1. Case: Cast aluminum, stem-mounted, flange less.
2. Size: 4-1/2-inch diameter.
3. Window: Clear glass.
4. Connector: Brass.
5. Scale: White aluminum with black graduation and markings.
6. Pointer: Black, adjustable.
7. Mid-Scale Accuracy: One percent.
8. Scale: PSI.
9. Basis of Design: Trerice Model 600CB.

2.03 THERMOMETERS

A. Thermometers - Adjustable Angle: Red or blue appearing organic liquid in glass, ASTM E 1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
1. Size: 9-inch scale.
2. Window: Acrylic.
3. Scale: Aluminum, white background, black graduations and markings.
4. Stem: 3/4-inch NPT brass (aluminum for installation in air ducts).
5. Accuracy: 2 percent, per ASTM E 77.
6. Calibration: 0-160 with 2 Degrees F graduations.
7. Basis of Design: Trerice BX9.

2.04 THERMOMETER WELLS

A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.
1. Material: Brass for use in copper piping.
2. Material: Stainless steel, for use in steel piping.
3. Extension Neck Length: Nominal thickness of 2-inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
4. Insertion Length: To extend to center of pipe.
5. Cap: Threaded, with chain permanently fastened to socket.
6. Heat Transfer Fluid: Oil or graphite.

2.05 PRESSURE-GAUGE FITTINGS

A. Valves: NPS 1/4 (DN8) brass or stainless-steel needle type.

B. Syphons: NPS 1/4 (DN8) coil of brass turbine with threaded ends.

C. Snubbers: ASME B40.5, NPS 1/4 (DN8) brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.06 TEST PLUGS

A. Test Plug: 1/4-inch brass fitting and cap for receiving 1/8-inch outside diameter pressure or temperature probe with Viton core for temperatures up to 200 degrees F.

B. Description: Nickel-plated, brass-body test plug in NPS 1/2 (DN15) fitting.

C. Body: Length as required to extend beyond insulation.

D. Pressure Rating: 500 PSIG minimum.

E. Core Inserts: One or two self-sealing valves, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gauge.

F. Core Material for Air, Water, Oil and Gas: 20 to 200 degrees F, chlorosulfonated polyethylene synthetic rubber.

G. Test Plug Cap: Gasketed and threaded cap, with retention chain or strap.

H. Test Kit: Pressure gauge and adapter with probe, two bimetal dial thermometers, and carrying case.
   1. Pressure Gauge and Thermometer Ranges: Approximately two times the system's operating conditions.

2.07 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)

A. Bellows-type, stainless steel casing and bellows, pressure rated, tested and certified in accordance with PDI WH-201.

B. Piston-type, copper, brass or stainless steel with O-ring piston, pressure rated, tested and certified in accordance with PDI WH-201.

2.08 TRAP PRIMERS

A. Electronic trap seal automatic primer valve with integral anti siphon protection monitored by the DDC system for monitoring. Coordinate quantity, locations and voltage characteristics for control points and with Section "Controls."

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2-inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

B. Where adequate space is not available, use meters specifically designed for short pipe lengths.

C. Install meters in accordance with manufacturer's instructions, and as shown on Drawings. Provide recommended upstream and downstream straight pipe length for accurate reading.

D. Temperature Gauges:
   1. Install in vertical upright position, tilted so as to be easily read at floor.
   2. Thermometer Wells: Install in piping in vertical upright position. Fill well with oil or graphite, secure cup.

E. Pressure Gauges:
   1. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position, visible from floor.
   2. Locations: Install in the following locations, and elsewhere as indicated.
      a. At each pump inlet and outlet.
      b. At inlet and discharge of each pressure reducing valve.
      c. At make-up water service outlets.

F. Provide instruments with scale ranges selected according to service with largest appropriate scale.

G. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

H. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

I. Locate test plugs adjacent to thermometers and thermometer sockets, adjacent to pressure gauges and pressure gauge taps, adjacent to control device sockets, or where indicated.

J. Thermometer Range/Graduations:

System	Temperature (Degrees F)	Graduations (Degrees F)
Cold Water	25-125	1
Hot Water	30-240	2

K. Pressure Gauge Range/Graduations:

System	Pressure (PSI)	Graduations (PSI)
Cold Water	0-100	1
Hot Water	0-100	1
Compressed Air	0-160	1

3.02 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)

A. Locate shock absorbers in supply pipe in accordance with recommendations of Plumbing and Drainage Institute PDI-WH201. Install ahead of solenoid operated valves. Determine size of absorber by fixture unit value of fixture supplied, using PDI symbols to designate sizes. Provide access panel for each shock absorber.

B. Water Hammer Arrestors: Install in upright position, in locations and of sizes in accordance with PDI WH-201, and elsewhere as indicated

END OF SECTION

SECTION 22 0523
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Valves, General
   2. Globe Valves
   3. Balancing Valves
   4. Ball Valves
   5. Butterfly Valves
   6. Swing Check Valves
   7. Lift Check Valves
   8. Backflow Prevention Assemblies
   9. Pressure Regulating Valve-Domestic Water
   10. Thermostatic Master Mixing Valves (ASSE 1017 Rated)
   11. Thermostatic Point-of-Use Mixing Valves (ASSE 1070 Rated)

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. NSF 61, Annex G and/or NSF/ANSI 372 for potable water services. Valves must be 3rd party certified.
   2. ISO 9001 Certified.
   3. IAPMO Certified for Low Lead.

C. Source Limitations for Valves: Obtain each type of valve from a single source and from a single manufacturer.

D. Model numbers indicated as Basis-of-Design indicate valve characteristics. All valves are to meet code Low Lead/Lead Free Standards.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations for Valves: Obtain each type of valve from a single source and from a single manufacturer.

B. Valves - General:
   1. Apollo
   2. Armstrong
   3. ASCO
   4. Cla-Val

5. Conbraco
6. Crane
7. Clow
8. Hammond
9. Hays
10. Jenkins
11. Josam
12. Kennedy
13. Milwaukee
14. Mueller
15. Nibco
16. Smith
17. Stockham
18. Tour Anderson
19. Caleffi
20. Wade
21. Watts
22. Wilkins
23. Or approved equivalent.

C. Backflow Preventers:
1. Apollo
2. Cla-Val
3. Conbraco
4. Watts
5. Or approved equivalent.

D. Balancing Valves:
1. Griswold
2. Hays
3. Armstrong CBV
4. Tour Anderson
5. Or approved equivalent.

E. Thermostatic Master Mixing Valves (ASSE 1017 Rated):
1. Holby Tempering Valve
2. Lawler Series 66
3. Leonard Type TM
4. Powers LFMM430 (Lead Free)
5. Symmons Temp Control Series 5
6. Or approved equivalent.

F. Thermostatic Point-of-Use Mixing Valves (ASSE 1070 Rated):
1. Lawler Model TMM 1070
2. Leonard Series LFMMV
3. Powers Hydroguard Series LFLM495
4. Maxhue 5-230
5. Or approved equivalent.

G. Backflow Prevention Assemblies - Reduced Pressure Zone Backflow Preventer (RPBP) for High Hazard Applications - 2-inches and Smaller:
1. Febco 860-with 650A.
2. Conbraco 40-210-AGD.
3. Wilkins 375-XL-SAG.
4. Watts 919-QT-S valve with 919AGC or 919AGF.
5. Or approved equivalent.

H. Backflow Prevention Assemblies - Reduced Pressure Zone Backflow Preventer (RPBP) for High Hazard Applications - 2-1/2-inches and Larger:
   1. Febco 860 with 758A.
   2. Conbraco Apollo 40-700 with 758A.
   3. Watts 909-S-NFA-NRS with AGC.
   4. Wilkins 375-FSC.
   5. Or approved equivalent.

I. Backflow Prevention Assemblies - Double Check Valve Assembly (DCVA) for Low Hazard Applications - 2-inches and smaller:
   1. Febco 850-650A
   2. Conbraco Apollo 40-110-T2
   3. Watts 007-QT-FDA-S
   4. Wilkins 350-S-XL
   5. Or approved equivalent.

J. Backflow Prevention Assemblies - Double Check Valve Assembly (DCVA) for Low Hazard Applications - 2-1/2-inches and larger:
   1. Conbraco Apollo 45-11-1
   2. Watts 709-DCDA with 77F-01-FDA-12
   3. Or approved equivalent.

K. Atmospheric Vacuum Breaker:
   1. Conbraco Apollo 38-201
   2. Watts 288 A-C
   3. Wilkins 35VCH
   4. Cash Acme V101C
   5. Or approved equivalent.

2.02 VALVES - GENERAL

A. General:
   1. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
   2. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 4-inches and smaller. Provide gear operators for quarter-turn valves 6-inches and larger and plug valves installed over 5-feet above finished floor.
   3. Valve Identification: Manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

B. Valves in Insulated Piping: With 2-inch stem extension and following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation on valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied.
   2. Butterfly Valves: With extended neck.

C. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves, ASME B16.5 for steel valves.
   2. Grooved: With grooves according to AWWA C606.
   3. Solder Joint: With sockets according to ASME B16.18.
   4. Threaded: With thread according to ASME B1.20.1.

D. Valve Bypass and Drain Connections: MSS SP-45.

E. Building Service:
   1. Shutoff and Isolation Valves:
      a. Pipe Sizes 3-inches and Smaller: Ball Valve.
      b. Pipe Sizes 4-inches and Larger: Butterfly Valve.
   2. Drain Service: Ball valves.

3. Strainer Blow-Off: Ball Valve.
4. Bypass Around Pressure-Reducing Valves: Globe Valves.
5. Check Valves: Swing or Lift.

2.03 GLOBE VALVES

A. 3-inches and Smaller: Class 200, 200 lb. SWP, MSS SP-80, ASTM B61, cast bronze body, bronze bonnet, bronze disc, bronze packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel.

2.04 BALANCING VALVES

A. Maximum 125 PSIG System Working Water Pressure.

B. Manual Set Balancing Valves:
   1. Valves are to be of the "Y" pattern, equal percentage globe-style and provide three functions:
      a. Precise flow measurement.
      b. Precision flow balancing.
      c. Positive drip-tight shut-off.
   2. Valve to provide multi-turn, 360 degree adjustment with micrometer type indicators located on the valve handwheel. Valves have a minimum of five full 360 degree handwheel turns. 90 degree circuit-setter style ball valves are not acceptable. Valve handle to have hidden memory feature, which will provide a means for locking the valve position after the system is balanced. Valves to be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi to have two 1/4-inch threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve. Valves to be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug to be brass. The handwheel to be high-strength resin.

2.05 BALL VALVES

A. All ball valves on brazed piping are to be three-piece.

B. 2-1/2-inches and Smaller: MSS SP-110, 400-600 PSI, two-piece full port ball configuration, bronze body, extended soldered ends for copper pipe and threaded ends for iron pipe, brass or stainless steel ball, Teflon seat, brass stem, and extended steel handle, brass stem, or extended steel handle. Apollo 70CLF 100 Series two-piece.

C. 3-inches and Larger: MSS SP-110, 400-600 PSI, three-piece full port ball configuration, bronze body, extended soldered ends for copper pipe and threaded ends for iron pipe, brass or stainless steel ball, Teflon seat, brass stem, or extended steel handle. Apollo 82-100/82A 140 Series three-piece.

2.06 BUTTERFLY VALVES

A. Select lug type valves.

B. 6-inches and Smaller: 200 PSI, ductile iron body, extended neck, stainless steel stem with stainless steel disc, reinforced resilient EPDM seat, memory stop control, lever handle through 5-inches, size and worm gear operator for 6-inches and larger. Mount stem in horizontal position. Manual lever and lock. . MSS SP-58, Type 1.

2.07 SWING CHECK VALVES

A. 2-inches and Smaller: Class 125, bronze body, horizontal swing, regrinding type, Y-pattern, renewable disc. Nibco 413. MSS SP-80.

B. 2-1/2-inches and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends. Nibco F918. MMS SP-71.

C. Rubber Flapper Check Valve: Horizontal or vertical upward flow installation. Working pressure to 175 PSI. Ductile iron or cast iron body. Steel reinforced Buna-N rubber flapper epoxy coating on wetted parts. MSS SP-80.

2.08 LIFT CHECK VALVES

A. 3-inches and Smaller: Bronze body, 125 PSI, spring loaded, Teflon seat. Steam Service, Teflon Disc: Apollo CYB-LF (Lead Free). Water, Gas or Oil Service, Buna-N Disc: MSS SP-80.

B. 4-inches and Larger: Stainless or bronze body, 125 PSI, spring loaded, silent check, bronze, stainless steel or TFE seat and disc. 125 PSI Valmatic Series 1800.

2.09 BACKFLOW PREVENTION ASSEMBLIES

A. General: Assemblies model numbers listed below are for general comparison. Project specific model numbers to be verified contractor as approved by jurisdiction where project is located.

B. Reduced Pressure Zone Backflow Preventer (RPBP) for High Hazard Applications:
   1. 2-inches and Smaller: Assembly consists of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies include test cocks and pressure-differential relief valve located between two positive seating check valves and comply with requirements of ASSE Standard 1013 and AWWA C511. Bronze construction, threaded ends, stainless steel internal parts, FDA strainer, and air gap fitting. Route pipe from air gap fitting to approved waste receptor.
   2. 2-1/2-inches and Larger: Assembly consists of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies include test cocks and pressure-differential relief valve located between two positive seating check valves and comply with requirements of ASSE Standard 1015 and AWWA C511. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts, bronze seats, and FDA strainer.

C. Double Check Valve Assembly (DCVA) for Low Hazard Applications:
   1. 2-inches and Smaller: Assembly consists of shutoff ball valves in inlet and outlet, and FDS strainer on inlet. Assemblies include test cocks and two positive seating check valves and comply with requirements of ASSE Standard 1015 and AWWA C510. Bronze construction, threaded ends, and stainless steel internal parts.
   2. 2-1/2-inches and Larger: Assembly consists of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies include test cocks and two positive seating check valves and comply with requirements of ASSE Standard 1015 and AWWA C510. Epoxy coat cast iron body construction, strainer flanged ends, and stainless steel internal parts.

D. Atmospheric Vacuum Breaker: Assembly consists of a bronze vacuum breaker body with silicone disc, and full size orifice. Device to be IAPMO listed, meet ASE standard 1001, and ANSI standard A113.1.1 rough chrome plate finish.

2.10 PRESSURE REGULATING VALVE-DOMESTIC WATER

A. Water: Bronze body, diaphragm or piston type, spring actuated, with separate or integral strainer, pressure range to suit conditions, approved for potable water use. Provide shutoff valves, pressure relief valves, unions, drain valve and bypass.

2.11 THERMOSTATIC MASTER MIXING VALVES (ASSE 1017 RATED)

A. Thermostatic type with bronze body construction, corrosion resistant, materials, union end stops, check inlets with strainers, 0-200 degree farenheit dial thermometer and discharge shut-off valve. Mixing valves to meet ASSE 1017.

B. Install mixing valve per manufacturer's instruction manual.

C. Maximum required delta temperature differential between hot water supply temperature and delivery temperature is 15 degrees F. Set valve outlet temperature per drawing requirements.

D. Flow from the tempered water circulating pump to be split to mixing valve and building hot water heating system.

2.12 THERMOSTATIC POINT-OF-USE MIXING VALVES (ASSE 1070 RATED)

A. Thermostatic type with bronze body construction, corrosion resistant, materials, union end stops, check inlets with strainers, 0-200 degree farenheit dial thermometer and discharge shut-off valve. Mixing valves to meet ASSE 1070.

B. Install mixing valve per manufacturer's instruction manual.

C. Maximum required delta temperature differential between hot water supply temperature and delivery temperature is 15 degrees F. Set valve outlet temperature per drawing requirements.

D. Flow from the tempered water circulating pump to be split to mixing valve and building hot water heating system.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves and weld ends.
   3. Set angle, gate and globe valves closed to prevent rattling.
   4. Set ball valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Do not attempt to repair defective valves; replace with new valves.

E. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate Sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

F. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose end adapter and cap on chain for each valve that must be installed with stem below horizontal plane. Ensure installation provides full stem movement.

G. Insulation: Where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.

H. Mechanical Actuators: Install with chain operators where indicated. Extend chains to 5-feet above floor and hook to clips to clear aisle passage.

I. Stem Selection: Outside screw and yoke stems, except provide inside screw, non-rising stem where space prevents full opening of OS&Y valves.

J. Seats: Renewable seats, except where otherwise indicated.

K. Installation of Check Valves:
   1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow. Only install where there are 10 pipe diameters of straight pipe upstream of valve.
   2. Lift Check Valves: Install in piping line with stem vertically upward, position for proper direction of flow.

L. Balancing Valves: Install with flow in the direction of the arrow on the valve body and installed at least five pipe diameters downstream from any fitting, and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream from the balancing valve should be free of any fittings. When installed, easy and unobstructed access to the valve handwheel and metering ports for adjustment and measurement are to be provided. Mounting of valve in piping must prevent sediment build-up in metering ports.
   1. Provide a balancing valve, check valve, and isolation valve at each hot water return (HWR) connection to the HWR main returning to the hot water system.

M. When soldering, use paste flux that are approved by the manufacturer for use with lead free alloys.

3.02 VALVE ADJUSTING AND CLEANING

A. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.

B. Valve Identification. Tag valves per Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated on Drawings, use the following:
   1. Shutoff Service: Ball or butterfly valves.
      a. Locate valves to be readily accessible without the use of a ladder. Valves which cannot be located such will be noted in the Shop Drawings for review.
   2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   3. Throttling Service: Globe valves or Pressure reducing valves.
   4. Ejector and Sump Pump-Discharge Check Valves:
      a. 2-inches and Smaller: Bronze swing or spring-loaded lift check valves with bronze disc.
      b. 2-1/2-inches and Larger: Rubber flapper swing check valves with lever and weight.
   5. Domestic Water and Circulation Pump Discharge Check Valves:
      a. 2-inches and Smaller: Bronze body, spring loaded, lead free, lift check.
      b. 2-1/2-inches and Larger: Silent lift check valve, lead free.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Valves, except wafer types, with the following end connections.
   1. For Copper Tubing, 2-inches and Smaller. Threaded ends except where solder-joint valve-end.
   2. For Copper Tubing, 2-1/2-inches to NPS 4-inches. Flanged ends except where threaded valve-end.
   3. For Copper Tubing: 5-inches and Larger: Flanged ends.
   4. For Steel Piping, 2-inches and Smaller: Threaded ends.
   5. For Steel Piping, 2-1/2-inches to NPS 4-inches: Flanged ends except where threaded valve-end.
   6. For Steel Piping, 5-inches and Larger: Flanged ends.

3.04 BACKFLOW PREVENTERS

A. Install where indicated, and where required by code. Where practical, locate in same room as equipment being protected.

B. Submit product cut sheets to local AHJ for approval prior to purchase.

C. Install as close to wall as possible with clearances for access and maintenance as required by AHJ.

D. Coordinate exact location of installation and type of backflow device serving a particular piece of equipment with AHJ and Architect prior to purchase and installation.

E. Provide wall/floor brackets that are of fully welded, hot dipped galvanized construction (HDG), fabricated to meet field conditions. Mount backflow preventer to brackets using HDG "U" type bolts and nuts.

F. Contact: Contact local water district/backflow specialist and request backflow testing and certification. Install backflow devices per UPC and local water district/backflow specialist requirements.

G. Route waste piping from air gap waste fitting concealed within walls to point of air gap termination at indirect waste receptor.

3.05 PRESSURE REGULATING

A. Provide inlet and outlet ball valves, and globe valve bypass. Provide pressure gauge on valve outlet.

B. Provide pressure relief valve piped full size to indirect waste receiver or floor drain.

END OF SECTION

SECTION 22 0529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Piping Hangers and Supports
   2. Wall and Floor Sleeves
   3. Anchors
   4. Flashing
   5. Miscellaneous Metal
   6. Miscellaneous Materials

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Hanger spacing installation and attachment to meet all manufacturers requirements and MSS SP-58.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, equipment hangers/supports, and seismic restraint by a qualified Structural Professional Engineer.
      a. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.
   3. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems whose products have been in satisfactory use in similar service for not less than 10 years.
   4. Support systems to be supplied by a single manufacturer.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.07 PERFORMANCE REQUIREMENTS

A. General - Provide pipe and equipment hangers and supports in accordance with the following:
   1. When supports, anchorages, and seismic restraints for equipment, and supports, anchorages, and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor is responsible for their design.

2. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Engineered Support Systems:
   1. Support frames such as pipe racks or stanchions for piping and equipment which provide support from below.
   2. Equipment and piping support frame anchorage to supporting slab or structure.

C. Provide channel support systems, for piping to support multiple pipes capable of supporting the combined weight of supported systems, system contents and test water.

D. Provide heavy-duty steel trapezes for piping to support multiple pipes capable of supporting the combined weight of supported systems, system contents and test water.

E. Provide seismic restraint hangers and supports for piping and equipment. See Section 22 0548.

F. Obtain approval from AHJ for seismic restraint hanger and support system to be installed for piping and equipment. See Section 22 0548.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Pipe Hangers/Supports:
   1. Pipe Hangers/Supports:
      a. B-Line Systems, Inc.
      b. Anvil International
      c. HOLDRITE
      d. Erico Co., Inc.
      e. Or approved equivalent.
   2. Pipe Guides:
      a. Flexonics
      b. Mason Industries
      c. Amber-Bush
      d. Metraflex
      e. Pipe Shields
      f. Swebco
      g. Flex-Weld
      h. Advanced Thermal Systems
      i. Or approved equivalent.
   3. Channel Support Systems:
      a. B-Line Systems, Inc.
      b. Anvil International, Anvit-Strut
      c. Erico Hanger Co., Inc.; O-Strut Div.
      d. Unistrut Corp.
      e. HOLDRITE EZ-Strut Systems
      f. Or approved equivalent.
   4. Thermal-Hanger Shield Inserts:
      a. Erico Hanger Co., Inc.
      b. Pipe Shields, Inc.
      c. Rilco Manufacturing Co., Inc.
      d. HOLDRITE Insulation Couplings
      e. Or approved equivalent.
   5. Freestanding Roof Supports:
      a. Erico Hanger Co., Inc.
      b. Nelson-Olsen Inc.
      c. Or approved equivalent.
   6. Pipe Alignment and Secondary Supports:
      a. HOLDRITE

b. Starquick
c. Or approved equivalent.

B. Wall and Floor Sleeves:
1. Below Grade and High Water Table Areas:
a. Modular Link Sealing System at Pipe Sleeves:
1) Thunderline Corporation
2) Or approved equivalent.
2. Pre-Engineered Firestop Pipe Penetration Systems:
a. HOLDRITE HydroFlame
b. Or approved equivalent.
3. Below Grade Pipe Sleeves:
a. Thunderline Corporation "Link Seal".
b. Or approved equivalent.

C. Anchors:
1. Anchor-It
2. Hilti Hit System
3. Epcon System
4. Power Fast System
5. Or approved equivalent.

D. Flashing:
1. Fastenal
2. Or approved equivalent.

E. Miscellaneous Metal:
1. See Miscellaneout Metal article below.

F. Miscellaneous Materials:
1. Powder-Actuated Fastener Systems:
a. Gunnebo Fastening Corp.
b. Hilti, Inc.
c. ITW Ramset/Red Head.
d. Masterset Fastening Systems, Inc.
e. Or approved equivalent.

2.02 PIPING HANGERS AND SUPPORTS

A. Horizontal Piping Hangers and Supports - Horizontal and Vertical Piping, and Hanger Rod Attachments:
1. Factory fabricated horizontal piping hangers and supports to suit piping systems in accordance manufacturer's published product information.
2. Use only one type by one manufacturer for each piping service.
3. Select size of hangers and supports to exactly fit pipe size for bare piping and to exactly fit around piping insulation with saddle or shield for insulated piping.
4. Provide copper-plated hangers and supports for uninsulated copper piping systems.
5. Provide padded pipe hangers, clamps and supports for thermoplastic piping system.
6. Install no hub cast iron pipe and fittings per CISPI 301-09 Installation Procedures for Hubless Cast Iron Pipe and Fittings for Sanitary and Storm Drain Waste and Vent Piping Applications. Brace hubless cast iron pipe and fittings 5-inch and larger with HOLDRITE No Hub Pipe Restraints or approved equivalent.

B. Pipe Hangers, Slides and Clamps:
1. Hanger Rods: Hanger rods continuously threaded or threaded ends only in concealed spaces and threaded ends only in exposed spaces; finish electro-galvanized or cadmium-plated in concealed spaces and prime painted in exposed spaces; sizes per MSS.
2. Hanger Rod Couplings: Malleable iron rod coupling with elongated center sight gap for visual inspection; to have same finish as hanger rods.

3. Pipe Rings for Hanger Rods: Pipe sizes 2-inch and smaller, MSS SP Type 6 or Type 10, or approved equivalent. Pipe sizes 2-1/2-inches and larger, clevis type hangers with adjustable nuts on rod. MSS SP Type 1. Pipe rings to have same finish as hanger rods.
4. Pipe Slides: Type 35 reinforced Teflon slide material (3/32-inch minimum thickness) bonded to steel; highly finished steel or stainless steel contact surfaces to resists corrosion; 60-80 PSI maximum active contact surface loading; steel parts 3/16-inch minimum thickness; attachment to pipe and framing by welding.
5. Pipe Guides:
   a. Furnish and install pipe guides on continuous runs where pipe alignment must be maintained. Minimum two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides securely to pipe and structure. Any contact with chilled water pipe is not to permit heat to be transferred in sufficient quantity to cause condensation on any surface.
   b. Furnish and install guides approximately 4 pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Guides are not to be used as supports and are in addition to other pipe hangers and supports.
6. Channel Type Pipe Hanging System: Framing members No. 12 gauge formed steel channels, 1-5/8-inch square, conforming to ASTM A570 GR33, one side of channel to have a continuous slot with in turned lips; framing nut with grooves and spring 1/2-inch size, conforming to ASTM 675 GR60; screws conforming to ASTM A307; fittings conforming to ASTM A575; parts enamel painted or electro-galvanized.

C. Building Attachments:
   1. Factory fabricated attachments to suit building substructure conditions and in accordance with manufacturer's published product information.
   2. Select size of building attachments to suit hanger rods.

D. Saddles and Shields:
   1. Factory fabricated saddles or shields under piping hangers and supports for insulated piping.
   2. Size saddles and shields for exact fit to mate with pipe insulation. 1/2 round, 18 gauge, minimum 12-inches in length (4-inch pipe and larger to be three times longer than pipe diameter).

E. Thermal-Hanger Shield Inserts: 100-PSI (690-kPa) minimum compressive strength insulation, encased in sheet metal shield.
   1. Material for Cold Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with vapor barrier.
   2. Material for Hot Piping: Water-repellent-treated ASTM C533, Type 1 calcium silicate.
   3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
   4. For Clevis or Band Hanger: Insert and shield to cover lower 180 degrees of pipe.
   5. Insert Length: Extend 2-inches beyond sheet metal shield for piping operating below ambient air temperature.
   6. Thermal Hanger Shield Inserts should be provided at the hanger points and guide locations on pipes requiring insulation. The Inserts should consist of Polyisocyanurate (urethane or phenolic insulation) encircling the entire circumference of the pipe with a 360 degree PVC (1.524 mm thick) with a living hinge and J lock and installed during the installation of the piping system.

F. Roller Hangers:
   1. Adjustable roller hanger. Black steel yoke, cast iron roller. MSS Type 41.

G. Concrete Inserts:
   1. Malleable iron body, hot dipped galvanized finish. Lateral adjustment. MSS Type 18.

H. Continuous Concrete Insert:
   1. Steel construction, minimum 12 gauge. Electrogalvanized finish. Pipe clamps and insert nuts to match.

I. Beam Clamps:

1. MSS Type 19 and 23, wide throat, with retaining clip.
2. Universal Side Beam Clamp: MSS Type 20.

J. Hangers for Pipe Size 2-inches and Smaller:
1. Adjustable swivel ring hanger, UL listed, Type 6 or Type 10.

K. Hangers for Pipe Size 2-1/2-inches and Larger:
1. Adjustable clevis type, UL listed, Type 1.

L. Riser Clamps:
1. Steel, UL listed. MSS Type 8.

M. Plumbers Tape:
1. Not permitted as pipe hangers or pipe straps.

N. Pipe Alignment and Secondary Support Systems:
1. Secondary Pipe supports for general applications (Non-Acoustical).
   a. Supports will be manufactured in compliance with IAPMO Product Standard PS 42-96. All products provided will be listed by IAPMO for secondary pipe support.
   b. Supports may be used when sound and/or vibration transfer is not a concern.
2. Secondary pipe supports for sound and vibration attenuation (Acoustical).
   a. Supports will be manufactured in compliance with IAPMO Product Standard PS 42-96. All products provided will be listed by IAPMO for secondary pipe support.
   b. Acoustical pipe supports will be manufactured and installed in compliance with International Organization for Standardization (ISO) 3822-1 with current amendments.
   c. Supports will be used when sound and/or vibration transfer is a concern. Locations where acoustical supports will be provided and include but are not limited to partition walls between living units, tenant spaces, retail units, mechanical rooms and lobbies.
   d. Support Products:
      1) Support to Wall Brace and Wall Stud Penetrations: HOLDRITE #261, #262, #263, and #264, or approved equivalent.
      2) Pipe Wrap for Pipe Clamps and Channel-Mounted Pipe Clamps: HOLDRITE #270, or approved equivalent.
      3) Pipe Wrap for Pipe Hangers: HOLDRITE #271, #272-2, and #272-4, or approved equivalent.
      4) Drop-Ear Fitting Support: HOLDRITE #265, or approved equivalent.
      5) Floor Riser Isolation Pads: HOLDRITE #275-T, or approved equivalent.
      6) Floor Isolation Pads (General Applications): HOLDRITE #274, #275, #276, and #278, or approved equivalent.

O. Freestanding Roof Pipe Supports:
1. Polyethylene high-density U.V. resistant quick "pipe" block with foam pad.
2. Recommended installation is for pipe blocks to be freestanding.
3. Piping 3-inches and larger mounted on type supports.

2.03 WALL AND FLOOR SLEEVES

A. Below Grade and High Water Table Areas:
1. Modular Link Sealing System at Pipe Sleeves: Neoprene gasket links bolted together around an interior sleeve forming a watertight seal. Use a modular link sealing system at sleeves to continuously fill the annular space between the pipe and the wall opening. Provide Link-seal Type S unless otherwise noted. OS with S-316 stainless construction for continuous water/tank walls.
2. Sleeves through concrete foundation walls and floors. Ductile iron pipe. Class 50 or 51 pipe conforming to ANSI/AWWA C151/A21.51, cement lined. Pipe sleeve will extend a minimum of 6-inches beyond outside perimeter of foundation. Final placement of sleeve will be confirmed with project's structural engineer. In areas with a high water table, provide AWWA C900, Class 235 plastic pipe in lieu of ductile iron pipe.

B. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.

C. Insulating Caulking: Eagle or Pitcher Super 66 high temperature cement.

D. Fabricated Accessories:
   1. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
   2. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide following minimum gauges for sizes indicated:
      a. Sleeve Size 4-inches in Diameter and Smaller: 18 gauge.
      b. Sleeve Sizes 5-inches to 6-inches: 16 gauge.
      c. Sleeve Sizes 7-inches and Larger: 14 gauge.
      d. Fire-Rated Safing Material:
         1) Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, 6 lbs./cu.ft. density with melting point of 1985 Degrees F and K value of 0.24 at 75 Degrees F.
         2) Calcium Silicate Insulation: Noncombustible, complying with FS-HH-I-523, Type II, suitable for 100 Degrees F to 1200 Degrees F service with K value of 0.40 at 150 Degrees F.

2.04 WALL AND FLOOR SLEEVES

A. Below Grade or High Water Table Areas:
   1. "Link-Seal" Pipe Sleeves: Neoprene gasket links bolted together around an interior sleeve forming a watertight seal. Provide Type S unless otherwise noted. Thunderline Corporation, or approved equivalent.

B. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies with water stop for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814. Use HOLDRITE HydroFlame or approved equivalent.

C. Fabricated Accessories:
   1. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
   2. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide the following minimum gauges for the sizes indicated:
      a. Sleeve Size 4-inches in Diameter and Smaller: 18 gauge.
      b. Sleeve Sizes 5-6-inches: 16 gauge.
      c. Sleeve Sizes 7-inches and Larger: 14 gauge.
      d. Fire-Rated Safing Material.
         1) Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, 6 lbs./cu.ft. density with melting point of 1985F and K value of 0.24 at 75F.
         2) Calcium Silicate Insulation: Noncombustible, complying with FS-HH-I-523, Type II, suitable for 100F to 1200F service with K value of 0.40 at 150F.

2.05 ANCHORS

A. General: Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project Structural Engineer. Provide anchor bolts suitable for cracked concrete.

B. Anchor Bolts:
   1. Anchor Bolts (Cast-In-Place): Steel bolts, ASTM A307. Nuts to conform to ASTM A194. Design values for shear and tension not more than 80 percent of the allowable listed loads.
   2. Anchor (Expansion) Bolts: Carbon steel to ASTM A307; nut to conform to ASTM A194; drilled-in type. Design values for shear and tension not more than 80 percent of the allowable listed loads.
   3. Anchor (Adhesive) Bolts: Consisting of two-part adhesive cartridge and zinc-plated Type A307 steel anchor bolt rod assembly with ASTM A194 nut.

2.06 FLASHING

A. Steel Flashing: 26 gauge galvanized steel.

B. Safes: 8 mil thick neoprene.

C. Caps: Steel, 22 gauge minimum, 16 gauge at fire-resistant structures.

2.07 MISCELLANEOUS METAL

A. Miscellaneous Metal: Provide miscellaneous metal items specified hereunder, including materials, fabrication, fastenings and accessories required for finished installation, where indicated on Drawings or otherwise not shown on drawings, that are necessary for completion of the project. The Contractor is responsible for their design.
   1. Fabricate miscellaneous units to size, shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.

B. Structural Shapes: Where miscellaneous metal items are needed to be fabricated from structural steel shapes and plates, provide members constructed of steel conforming with requirements of ASTM A36 or approved equivalent.

C. Steel Pipe: Provide seamless steel pipe conforming to requirements of ASTM A53, Type S, Grade A, or Grade B. Weight and size required as specified.

D. Fasteners: Provide fasteners of types as required for assembly and installation of fabricated items; surface-applied fasteners are specified elsewhere.

E. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.

F. Miscellaneous Materials: Provide incidental accessory materials, tools, methods and equipment required for fabrication.

G. Provide hot dipped galvanized components for items exposed to weather.

2.08 MISCELLANEOUS MATERIALS

A. Powder-Actuated Drive-Pin Fasteners: Powder actuated type, drive pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

C. Grout: ASTM C1107, Grade B, factory mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
   1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
   2. Properties: Nonstaining, noncorrosive, and non-gaseous.
   3. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.

D. Provide hot dipped galvanized components for items exposed to weather.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Examination:
   1. Verify building materials to have hangers and attachments affixed in accordance with hangers to be used. Provide supporting calculations.

B. Preparation:
   1. Examine Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall," "2-Hour Fire/Smoke Barrier,"

and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.

C. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate proper placement of inserts, anchors and other building structural attachments.

D. Installation:
   1. Building Attachments:
      a. Install within concrete or on structural steel or wood. Attachment to Wood Structure: Provide MSS Type 34 for attachment to wooden beam or approved attachment for a wood structure.
      b. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints and at changes in direction of piping.
      c. Install concrete inserts before concrete is placed; fasten insert secure to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.
   2. Bolting:
      a. General: Provide bored, drilled or reamed holes for bolting to miscellaneous structural metals, frames or for mounts or supports. Flame cut, punched or hand sawn holes will not be accepted.
   3. Pipe Curb Assemblies:
      a. Provide prefabricated units for roof membrane and insulation penetrations related to equipment. Coordinate with roofing system. Set supports on the structural deck. Do not set supports on insulation or roofing. Provide level supports by prefabricated pitch built into the curb.
      b. Pipe Curb Assemblies: Provide for piping and electrical conduit which penetrates the structural roof deck to service equipment above the roof level (i.e., piping, electrical power and control wiring). Meet requirements of roof warranty.
      c. Piping above roof to be supported with freestanding roof pipe supports unless detailed otherwise. At roofing applications, the adhesion mastic is to be specifically submitted to and approved by the roofing system manufacturer/installer to maintain the integrity of all warranties.
      d. At concrete floors, install a polyurethane mastic to the support block and adhere in place.
   4. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor wall, and through equipment room walls and floors.
   5. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
      a. Install fabricated pipe sleeve.
      b. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve I.D. with specified material.
      c. Seal each end airtight with a resilient nonhardening UL listed fire resistant ASTM 814 sealant.
   6. Piping penetrations through Fire-rated (1 to 3 hour) Assemblies:
      a. Select and install pre-engineered pipe penetration system in accordance with the UL listing and manufacturer's recommendation.
      b. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814. Use HOLDRITE HydroFlame or approved equivalent.
   7. Vertical Piping:
      a. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.

b. Riser clamps to be directly under fitting or welded to pipe. Provide neoprene pads for all systems except natural gas.
c. Riser to be supported at each floor penetration.
d. Provide structural steel supports at the base of pipe risers. Size supports to carry forces exerted by piping system when in operation.

E. Adjusting and Painting:
1. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping and equipment to proper level and elevations.
2. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.

F. Testing:
1. Powder-Actuated Inserts: Test powder-actuated insert attachments with a minimum load of 100 pounds.

3.02 PIPING HANGERS AND SUPPORTS

A. Hangers and Supports:
1. Pipe Hanger and Support Installation: Install hangers, supports, clamps, and attachments as required to properly support piping from building structure. For horizontally hung grooved-end piping, provide a minimum of 2 hangers per pipe Section.
2. Pipe Ring Diameters:
a. Uninsulated and Insulated Pipe, except where oversized pipe rings are specified: Ring inner diameter to suit pipe outer diameter.
b. Insulated Piping Where Oversized Pipe Rings are Specified and Vibration Isolating Sleeves: Ring inner diameter to suit outer diameter of insulation or sleeve.
3. Oversize Pipe Rings: Provide oversize pipe rings of 2-inch and larger size.
4. Pipe Support Brackets: Support pipe with pipe slides.
5. Steel Backing in Walls: Provide steel backing in walls to support fixtures and piping hung from steel stud walls.
6. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
a. Field assemble and install according to manufacturer's written instructions.
7. Pipe Guides:
a. Install on continuous runs where pipe alignment must be maintained. Provide a minimum of two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides to pipe structure. Any contact with chilled water pipe should not permit heat to be transferred in sufficient quantity to cause condensation on any surface.
b. Install approximately 4 pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Do not use as supports. Provide in addition to other required pipe hangers and supports.
8. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field -fabricated, heavy-duty trapezes.
a. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
b. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1
9. Group parallel runs of horizontal piping to be supported together on trapeze-type hangers.
10. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe.
11. Do not support piping from other piping.
12. Fire protection piping will be supported independently of other piping.
13. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.

14. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
15. Install powder-actuated drive pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
16. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
17. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.
18. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchor, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.
19. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
20. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping" is not exceeded.
21. Insulated Piping: (comply with the following)
    a. Attach clamps and spacers to piping.
        1) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
        2) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
        3) Do not exceed pipe stress limits according to ASME B31.9.
    b. Install MSS SP-58, Type 39 protection saddles, if insulation without a vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
        1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
    c. Install MSS SP-58, Type 40 protective shields on cold piping having a vapor barrier. Shields to span arc of 180 degrees.
        1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
    d. Shield Dimensions for Pipe, not less than the following:
        1) NPS 1/4 to NPS 3-1/2 (DN8 to DN 90): 12-inches long and 0.048-inch thick.
        2) NPS 4 (DN100): 12-inches long and 0.06-inch thick.
        3) NPS 5 and NPS 6 (DN125 and DN150): 18-inches long and 0.06-inch thick.
        4) NPS 8 to NPS 14 (DN200 to DN350): 24-inches long and 0.075-inch thick.
        5) NPS 16 to NPS 24 (DN400 to DN600): 24-inches long and 0.105-inch thick.
    e. Pipes NPS 8 (DN200) and Larger: Include wood inserts.
    f. Insert Material: Length at least as long as protective shield.
    g. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
22. Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms, IT rooms, MPOE room, and other electrical or electronic equipment spaces and enclosures, operating rooms, procedure rooms, MRI room, CT Scan rooms and the like. Within equipment rooms, provide minimum 3-feet lateral clearance from all sides of electric switchgear panels. Do not route piping above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with Electrical and coordinate exact pipe routing to provide proper clearance with such items.
23. Pipe supports and hanger spacing (pipe supported from structure or floor-supported) to meet the requirements of 1.3, References and Standards above.

3.03 WALL AND FLOOR SLEEVES

A. "Link-Seal" Pipe Sleeves: Install at slab on grade floor/below grade piping penetrations. Provide manufacturer's sleeve appropriate to seal type for pre-cast penetrations (except for DWV piping at slab on grade). Provide manufacturer's sleeve appropriate to seal type for pre-cast penetrations.

B. Fabricated Pipe Sleeves:
   1. Provide either steel or sheet metal pipe sleeves accurately centered around pipe routes. Size such that piping and insulation, if any, will have free movement within the sleeve, including allowance for thermal expansion. Sleeve diameter to be determined by local seismic clearance requirement, and by waterproofing requirements.
   2. Length: Equal to thickness of construction penetrated, except extend floor sleeves 1-inch above floor finish.
   3. Provide temporary support of sleeves during placement in concrete and other work around sleeves. Provide temporary end closures to prevent concrete and other materials from entering pipe sleeves.
   4. Seal each end airtight with a resilient nonhardening sealer, UL listed and fire rated per ASTM 814.

3.04 ANCHORS

A. Anchor Bolts:
   1. General: Install anchor bolts for mechanical equipment, piping and ductwork as required. Tightly fit and clamp base-supported equipment anchor bolts at equipment support points. Provide locknuts where equipment, piping and ductwork are hung.
   2. Anchor bolts (Cast-In-Place): Embed anchor bolts in new cast-in-place concrete to anchor equipment. Install a pipe sleeve around the anchor bolt for adjustment of the top 1/3 of the bolt embedment; sizes and patterns to suit the installation conditions of the equipment to be anchored.

B. Pipe Anchors:
   1. General: Provide anchors to fasten piping which is subject to expansion and contraction, and adjacent to equipment to prevent loading high forces onto the equipment.

3.05 FLASHING

A. Flash and counterflash where equipment passes through weather or waterproofed walls, floors and roofs.

B. Flash vent soil pipes with flashings per Division 01, General Requirements.

C. Flash floor drains over finished areas and roof drains, 10-inches clear on sides, minimum 36-inches x 36-inches sheet size. See Division 01, General Requirements. Fasten flashing to drain with clamping device.

D. Install built up fixtures (mop sinks, shower stalls, shower floors) with water sealing systems/membranes to meet Code and as prescribed by Division 01, General Requirements and Section 22 00 00, Plumbing Basic Requirements. Meet all Code testing requirements. Provide drainage devices with appropriate flanges, clamps, etc. to meet these installation requirements and ensure a water-tight installation.

3.06 MISCELLANEOUS METAL

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required. Avoid cutting concrete reinforcing when drilling for inserts.

Reference structural drawings and reinforcing shop drawings and determine locations of stirrups prior to drilling into concrete.

C. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete masonry or similar construction.

D. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

E. Setting Loose Plates: Clean concrete and masonry bearing surfaces of any bond reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
   1. Set loose leveling and bearing plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut-off flush with edge of the bearing plate before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated.
   2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

F. Fabrication:
   1. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on Drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates and similar devices. Hot dip galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.
   2. Finishes:
      a. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with 1 coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas with primer of same material before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.
      b. Metal in contact with Concrete, Masonry and Other Dissimilar Materials:
         1) Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
      c. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

G. Metal Fabrication:
   1. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
   2. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
   3. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of weld and methods used in correcting welding work, and with the following:

a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
b. Obtain fusion without undercut or overlap.
c. Remove welding flux immediately.
d. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.07 MISCELLANEOUS MATERIALS

A. See General Installation Requirements article above.

END OF SECTION

SECTION 22 0533
HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Heat Trace Cable (Freeze Protection)
   2. Heat Trace Cable (Flow Maintenance)

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.
   1. Section 22 07 00 - Plumbing Insulation
   2. Section 26 00 00 - Electrical Basic Requirements

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. UL 718K Pipe Heating Cable.
   2. CSA Design 3A, 3B, 3C.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Project Record Documents: Record physical locations of thermostats.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Provide minimum heat tracing capacities per linear foot as scheduled on Drawings.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Heat Trace Cable (Freeze Protection):
   1. FLX by Thermon
   2. SRF by Chomalox
   3. XL-Trace by Raychem
   4. CLT by Nelson
   5. Or approved equivalent.

B. Heat Trace Cable (Flow Maintenance):
   1. XL-Trace by Raychem
   2. Nelson/CLT
   3. Or approved equivalent.

2.02 HEAT TRACE CABLE (FREEZE PROTECTION)

A. General: Provide complete UL listed system of heating cables and components listed specifically for maintaining pipe temperature over entire piping system exposed to freezing temperatures.

B. Materials

1. Cable: Self-regulating flat, flexible, low-heat density, parallel electric heater strip consisting of 2 stranded circuit conductors enclosed in semi-conductive, polymer core insulated with plastic jacket protected with tinned-copper braid. Ability to overlapped without creating hot spots and is suitable for application on plastic, copper or steel pipe.
2. Voltage: See electrical drawings. Provide power connections, end seals, splices tap-offs and tees for a complete system.
3. Controls: Thermostat with fixed setpoint of 40 degrees F, remote bulb and capillary sensor enclosed in a NEMA 4 enclosure.

C. Minimum Exposure Temperature: 150 degrees F continuous.

2.03 HEAT TRACE CABLE (FLOW MAINTENANCE)

A. General:
1. Furnish and install UL Listed, CSA Certified, or FM approved system of heating cables, components and controls to maintain flow for high viscosity fluids.

B. Materials:
1. Self-regulating Heating Cable: Two nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature along its entire length, allowing the heating cable to be cut to length in the field. Covered with radiation-crosslinked, modified polyolefin dielectric jacket. Internal braid of tinned copper ground shield with an outer jacket of fluoropolymer (-CT), as required per Section 427-23 of the NEC-1996. For installation on plastic piping, apply using aluminum tape (AT-180).
2. Function: Operate on line voltage without the use of transformers.
3. Apply power connection, end seal, splice, and tee kit components in the field.

C. Components:
1. Provide UL listed heating-cable components, CSA certified, or FM Approved for use as part of the system to provide flow maintenance. Component enclosures rated NEMA 4X to prevent water ingress and corrosion. Installation does not require the installing contractor to cut into the heating-cable core to expose the bus wires. Connection systems that require the installing contractor to strip the bus wires or that use crimps or terminal blocks are not acceptable. Components that make an electrical connection to be reenterable for servicing. No component to use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

D. System Control:
1. Thermostatic Control-Line Sensing
a. Control by a line sensing thermostat variable set point set at 40 degrees F either directly or through an appropriate contactor.

PART 3- EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. General: Installation to be by Division 26, Electrical.

3.02 HEAT TRACE CABLE (FREEZE PROTECTION)

A. Location: Furnish heat trace and components for piping exposed to freezing conditions.

B. Install cable parallel to pipe or spiral wrap to achieve power density per linear foot of pipe to prevent freezing.

C. Heat Trace and Components are to be installed per the following:
1. Attach heat trace cable to pipe with polyester tape; increments not exceeding 1-foot.
2. Install thermostat capillary and bulb to pipe with polyester tape assuring a firm bulb contact with pipe. Install bulb without contact to heat cable. Maximum 12-inch spacing between tape.
3. Install thermostat at accessible location adjacent to pipe with minimum of exposed capillary.
4. Labeling: Provide “Electric Traced” label to outside of the pipes thermal insulation on alternating sides. Locate labels at intervals of 5 to 15-feet over entire length of heat tracing.

5. Coordinate installation with work under Division 26, Electrical for electrical service to each thermostat.
6. Coordinate application of heat tape with pipe insulation and weather jacketing.

3.03 HEAT TRACE CABLE (FLOW MAINTENANCE)

A. Location: See Drawings. Install heat trace within 2-feet of connecting plumbing fixtures.

B. Insulate grease waste piping after installation of heating cable. Test the heater circuits prior to insulation installation.

C. Pressure test grease waste piping before installing heating cable.

D. Provide as-built diagrams of the tracing installation. Include locations of power connections, end seals, access test points, splices, tee splices, identification of heater circuits and risers, and identification of circuit breakers.

E. Install with power connections, access test points, and end seals accessible. Clearly and permanently label with the circuit number.

F. Affix an “Electric Traced” label to the outside of the pipes thermal insulation on alternating sides at intervals of 5 to 15-feet immediately after the piping has been insulated.

G. Lay cable parallel on pipe or spiral wrap to maintain adequate temperature as required by pipe size and thermal properties of the pipe insulation to be applied.

H. Attach heat trace cable to pipe with polyester tape at increments not exceeding 1-foot.

I. Coordinate installation with work under Division 26, Electrical for electrical service to each thermostat.

J. For underground applications, install with waterproof insulation.

END OF SECTION

SECTION 22 0548

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Vibration Isolation
   2. Seismic - Bracing/Restraint Devices / Systems for Equipment and Piping

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.
   1. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
   2. Section 22 30 00 - Plumbing Equipment

1.03 REFERENCES AND STANDARDS

A. References and standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Vibration Isolation:
      a. Product Data: Provide catalog data indicating size, type, load and deflection of each isolator; and percent of vibration transmitted based on lowest disturbing frequency of equipment.
      b. Shop Drawings: Showing complete details of construction for steel and concrete bases including:
         1) Equipment mounting holes.
         2) Dimensions.
         3) Isolation selected for each support point.
         4) Details of mounting brackets for isolator.
         5) Weight distribution for each isolator.
         6) Details of seismic snubbers.
         7) Code number assigned to each isolator.
   2. Seismic Restraint:
      a. Shop Drawings: Show compliance with requirements of Quality Assurance article of this Section. Shop Drawings will be stamped by professional structural engineer licensed in state of Oregon.
      b. Calculations: Submit seismic calculations indicating restraint loadings resulting from design seismic forces. Include anchorage details. Calculations will be certified by professional structural engineer licensed in the state of Oregon.
      c. Certifications: For restraining devices submit pre-approval certification number from government agency. Where pre-approval is not available, submit testing performed by independent laboratory or calculations sealed by professional structural engineer licensed in state of Oregon certifying isolators and restraints will withstand seismic forces encountered.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Vibration Isolation:
      a. Except for packaged equipment with integral isolators, single manufacturer will select and furnish isolation required.

b. Deflections indicated will be minimum actual static deflections for specific equipment supported.
c. Isolator Stability:
    1) Size springs of sufficient diameter to maintain stability of equipment being supported with minimum horizontal to vertical stiffness ratio not less than 1:1. Spring diameters will be not less than 0.8 of the compressed height at rated load.
    2) Springs will have minimum additional travel to solid equal to 50 percent of the rated defection.
    3) Springs will support 200 percent of rated load when fully compressed without deformation or failure.
d. Maximum Allowable Vibration Levels: Peak vibration velocities not to exceed 0.08 in/sec. correct equipment operating at vibration velocities that exceed this criteria.

2. Seismic Restraint:
    a. Seismic restraint and anchorage of permanent equipment and associated systems listed below to building structure will be designed to resist total design seismic force prescribed in local building code:
        1) Floor- or roof-mounted equipment weighing 400 pounds or greater.
        2) Suspended, wall-mounted or vibration isolated equipment weighing 20 pounds or greater.
        3) Housekeeping slabs: provide reinforcement and anchorage to building structure.
    b. Where required, seismic sway bracing of suspended piping will meet the following:
        1) Pipe runs requiring seismic bracing will have a minimum of two traverse braces and one longitudinal brace. A longitudinal (or a traverse) brace at 90 degree change in direction may act as traverse (or longitudinal) brace if located within 2-feet of change in direction.
        2) Seismic bracing may not pass through seismic separation joint. Pipe runs that pass through seismic separation joints must be restrained within 5-feet of both sides of the separation.
        3) Seismic brace assembly spacing will not exceed 40-feet transverse and 80-feet longitudinal.
    c. Seismic sway bracing of suspended piping will be performed for the following:
        1) Piping 4-inches nominal diameter and larger, all cast iron and PVC piping and trapeze systems with total aggregate weight of 10 pounds/foot or greater.
    d. Seismic restraints may be omitted from suspended piping if the following conditions are satisfied:
        1) For piping supported by individual rod hangers 12-inches or less in length from top of pipe to bottom of structural support. Top connections to structure will have swivel joints, eye bolts, or vibration isolation hangers for the entire length of the system run.
        2) Lateral motion of the system will not cause damaging impact with surrounding systems or cause loss of system vertical support.
        3) System must be welded steel pipe, brazed copper pipe, or similar ductile material with ductile connections.
    e. Seismic restraints, including anchors to building structure, will be designed by registered professional structural engineer licensed in state of Oregon. Design will include:
        1) Number, size, capacity, and location of anchors for floor- or roof-mounted equipment. For curb-mounted equipment, provide design of attachment of both unit to curb and curb to structure.
        2) Number, size, capacity, and location of seismic restraint devices and anchors for vibration-isolation and suspended equipment. Provide calculations approval number verifying the horizontal and vertical ratings of the seismic restraint devices.

3) Number, size, capacity, and location of braces and anchors for suspended piping and ductwork on as-built plan drawings.
4) Maximum seismic loads will be indicated on Drawings at each brace location. Drawings will bear stamp and signature of registered professional structural engineer who designed layout of braces.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Vibration Isolation:
1. Amber-Booth.
2. California Dynamics Corporation.
3. Mason Industries, Inc.
4. Kinetics Noise Control.
5. Vibro-Acoustics.
6. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
7. Or approved equivalent.

B. Seismic - Bracing / Restraint Devices / Systems for Equipment and Piping:
1. Amber-Booth.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.
4. Hilti, Inc.
5. Mason Industries, Inc.
6. Kinetics Noise Control.
7. Unistrut.
8. ISAT, Inc.
9. Or approved equivalent.

2.02 VIBRATION ISOLATION

A. Type 1 - Neoprene Pad: Rubber or neoprene waffle pads, single layer, 5/16-inch thick with pattern repeating on 1/2-inch centers; 40 to 50 durometer hardness; maximum loading 50 PSI, 1/4-inch thick steel load distribution plate. Mason Type SWM.

B. Type 2 - Neoprene Mount: Double-deflection type, with steel or ductile-iron housing containing two separate and opposing, oil-resistant rubber or neoprene elements, factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Minimum static deflection of 0.20-inches. Mason Type BR.

C. Type 3 - Spring: Freestanding, laterally stable, open-spring isolators, factory drilled for bolting to structure and bonded to 1/4-inch thick rubber isolator pad attached to baseplate underside, mounts with leveling bolts. Mason Type SLFH.

D. Type 4 - Spring with Restraints: Laterally stable, open-spring isolators, factory drilled for bolting to structure and bonded to 1/4-inch thick rubber isolator pad attached to baseplate underside; mounts with leveling bolts; steel or cast iron housing for directional seismic snubbing with resilient vertical-limit stops. Mason Type SLR or SSLFH.

E. Type 5 - Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression; designed for 30-degree angular movement before hanger-rod misalignment without binding; seismic rebound washer; 1-inch minimum deflection. Mason Type PC30N.

F. Seismic Snubbers: Directional interlocking steel members restrained by one-piece molded neoprene bushing, minimum of 3/4-inch thick with minimum 1/8-inch air gap in all directions, capable of withstanding 3 times the rated load capacity. Mason Type Z-1225.

2.03 SEISMIC-BRACING/RESTRAINT DEVICES/SYSTEMS FOR EQUIPMENT AND PIPING

A. General Requirements for Restraint Components: Rated strengths, features, and applications will be as defined in reports by agency acceptable to authorities having jurisdiction.

B. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components will be at least four times the maximum seismic forces to which they will be subjected.

C. Anchor bolts for attaching to concrete will be seismic-rated, drill-in, and stud-wedge or female-wedge type. Provide anchor bolts suitable for cracked concrete.

D. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

E. Maximum 1/4-inch air gap, and minimum 1/4-inch thick resilient cushion.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:
   1. Vibration isolators and seismic restraint systems must be installed in strict accordance with manufacturers written instructions and certified submittal data.
   2. Provide mounts for equipment installed outdoors for wind loads of 30 lbs. psf applied to any exposed surface of isolated equipment.
   3. Do not install equipment or pipe which makes rigid contact with building slabs, beams, studs, walls, etc.
   4. Anchor baseplate to floor or structure. Provide rubber grommets and washers to isolate bolt from base plate. Under no circumstances will isolation efficiency be destroyed when bolting the isolators to floor.
   5. Building Penetrations: Isolate water piping penetrating wall, ceilings, floors or shafts from the structure by piping isolator or by 3/8-inch thick foamed rubber insulation. Install units flush with finished structure face, using one for each side as required. Cut units to length if longer than structure thickness. Caulk around pipe at equipment room wall.
   6. Pipe Hangers in Equipment Rooms: Support water and gas piping connected to rotating equipment within equipment rooms on spring and neoprene hangers. The first three hangers from a piece of vibrating equipment are to have a minimum of 1/2 static deflection of equipment isolators. Other isolators should have a minimum of 1/4 static deflection of equipment isolators.

3.02 VIBRATION ISOLATION EQUIPMENT INSTALLATION

A. Install isolation as indicated on Drawings by type and location and where indicated below.

B. Isolation Mounts:
   1. Position vibration isolation hanger elements as high as possible in hanger rod assembly but not in contact with building structure. Install hangers so that hanger housing may rotate full 360 degrees about rod axis without contacting any object.
   2. Where parallel running pipes are hung together on a trapeze which is isolated from the building, provide isolator deflections for largest determined by provisions for pipe isolation. Do not mix isolated and non-isolated pipes in the same trapeze.
   3. Install Type 3 and 4 isolators such that installed and operating heights of vibration isolated equipment is identical. Install limit stops so that they are out of contact during normal operation.
   4. Adjust leveling bolts and hanger rod bolts so isolated equipment is level and in proper alignment with connecting pipes.

C. Isolating Pipe Hangers:
   1. Install on compressed air and water piping connected to rotating equipment in the mechanical rooms. Provide isolating hanger supports for each piece of isolated equipment outside of mechanical rooms and where indicated.
   2. Isolated equipment items include base mounted pumps and line mounted pumps.

D. Inertia Bases: Unless otherwise indicated, provide a minimum operating clearance of 1-inch between structural steel frames and the concrete housekeeping pad or floor beneath equipment. Position isolator mounting brackets so that the required clearance is maintained.

E. Vibration isolators must not cause change of position of equipment or piping which would stress piping connections or misalign shafts or bearings.

F. Vibration isolators and seismic restraint systems must be installed in strict accordance with manufacturers written instructions and certified submittal data.

G. Anchor baseplate to floor or structure. Provide rubber grommets and washers to isolate bolt from base plate. Under no circumstances will isolation efficiency be destroyed when bolting the isolators to floor.

H. Anchorage: Adequately anchor or brace plumbing equipment and piping to resist displacement due to seismic action, include snubbers on equipment mounted on spring isolators, pumps and the like.

3.03 SEISMIC RESTRAINTS

A. General:
   1. Install and adjust seismic restraints so that equipment and piping supports are not degraded by restraints.
   2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

B. Supported Equipment: Each vibration isolation frame for supported equipment will have a minimum of four seismic snubbers mounted as close as possible to vibration isolators and/or frame extremities.

C. Bracing of Pipes: Branch lines may not be used to brace main lines.

D. Suspended Equipment and Piping Cable Method:
   1. Cables will be adjusted to the degree of slackness approved by Structural Engineer of Record.
   2. Uplift and downward restraint nuts and washers for Type 5 spring hangers will be adjusted so that there is a minimum 1/4-inch clearance.

E. Vibration isolators and seismic restraint systems must be installed in strict accordance with manufacturers written instructions and certified submittal data.

END OF SECTION

SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Plastic Nameplates
   2. Tags
   3. Pipe Markers
   4. Ceiling Tags
   5. Lettering and Graphics

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01. General Requirements.

B. In addition, provide:
   1. Schedules:
      a. Submit valve schedule for each piping system, in tabular format using Microsoft Word or Excel software. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.
      b. For renovations or expansions of existing systems, coordinate with Owner and develop valve schedule on existing schedule naming and format.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
   2. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 22, Plumbing Sections. Where more than a single type is specified for application, provide single selection for each product category.

B. Manufacturers:
   1. Brady Corporation.
   2. Champion America, Inc.
   3. Seton Identification Products.

4. Craftmark.
5. Brimer.
6. Or approved equivalent.

2.02 PLASTIC NAMEPLATES

A. Description: Engraving stock melamine plastic laminate in the size and thicknesses indicated, engraved with engraver' s standard letter style of the sizes and wording indicated, black with white core (letter color), punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Provide one-eighth-inch thick material.
   1. Letter Color: White.
   2. Letter Height: 1/2 inch.
   3. Background Color: Black.
   4. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
   5. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or devices/equipment. Include center hole to allow attachment.

2.03 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2-inch diameter.

B. Metal Tags: Polished Brass with stamped letters; tag size minimum 1-1/2-inch diameter with smooth edges.

C. Valve designations to be coordinated with existing valve identifications to ensure no repetitive designations are utilized.

D. Chart/Schedules: Valve Schedule Frames. For each page of a valve schedule, provide glazed display frame with removable mounting as appropriate for wall construction upon which frame is to be mounted. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

E. Valve Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks.

F. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7-inches.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
   4. Color: Yellow background with black lettering.

2.04 PIPE MARKERS

A. Color: Conform to ASME A13.1 and ANSI Z535.1.

B. Plastic Pipe Markers (for external diameters of 6-inches and larger including insulation): Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Plastic Tape Pipe Markers (for external diameters less than 6-inches including insulation): Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, metalized/detectable, minimum 6-inches wide by 4-mil thick, manufactured for direct burial service. Minimum information indicating flow direction arrow and identification of fluid being conveyed.

2.05 CEILING TAGS

A. Description: Steel with 3/4-inch diameter color coded head.

B. Color code as follows:

1. Orange - Plumbing equipment.
2. Green - Plumbing valves.
3. Ceiling tile labels, machine generated, adhesive backed tape labels with black letters, clear tape.

2.06 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Chiller No. 3, Air Handling Unit No. 42, Standpipe F12, and the like).

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces for stencil painting.

3.02 INSTALLATION

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Coordinate with the facility maintenance personnel to insure consistency with the existing tagging system.

C. Tag balancing valves with balanced GPM or CFM indicated after balancing is completed and accepted.

D. Install plastic nameplates with corrosive-resistant mechanical fasteners.

E. Install tags with corrosion resistant chain.

F. Install plastic pipe markers in accordance with manufacturer's instructions.

G. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

H. For exterior underground piping installations, Install underground plastic pipe markers with tracer wire 6 to 8-inches below finished grade, directly above buried pipe.

I. Identify pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates riveted to equipment body. Small devices, such as in-line pumps, may be identified with tags.

J. Identify control panels and major control components outside panels with plastic nameplates riveted to equipment body.

K. Identify valves in main and branch piping with metal tags. Indicate valve function and the normally open or closed positions on the valve tag.

L. Identify piping, concealed or exposed, with plastic tape pipe markers. Use metal tags on piping 3/4-inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20-feet (reduced to 10-feet in congested areas and mechanical equipment rooms) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction. Locate near branches, valves, control devices, equipment connections, access doors, floor/wall penetrations.

M. Access Doors: Provide markers or stenciled signs on each access door and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions.

N. Provide ceiling tags to locate valves or equipment above accessible ceilings. Locate in corner of ceiling tee grid closest to equipment.

O. Install valve schedule at each mechanical room.

3.03 SCHEDULE

A. Equipment Type:
   1. Identification:
   2. Background:
      a. Size:
      b. Color:
   3. Lettering:
      a. Size:
      b. Color:

END OF SECTION

SECTION 22 0593

TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Balancing water flow within distribution systems of all Division 22, Plumbing Sections, including sub-mains, branches, and terminals, to indicated quantities according to specified tolerances.
   2. Adjusting Plumbing systems to provide indicated quantities.
   3. Verifying that automatic control devices are functioning properly.
   4. Reporting results of the activities and procedures specified in this Section.

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Acceptable Balance Firm:
      a. General:
         1) Procure services of independent balance and testing agency which specializes in balancing and testing of plumbing systems, to balance, adjust and test water circulating. Minimum Experience: 5 years.
      b. Industry Standards: Testing and Balancing will conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
         1) NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
         2) ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
      c. Test Observation: If requested, conduct tests in the presence of the Architect or the Architect's representative.
   2. Provide proof of testing agency having successfully completed at least five projects of similar size and scope.
   3. Code Compliance: Perform tests in the presence of the Authority Having Jurisdiction (AHJ) where required by the Authority Having Jurisdiction (AHJ).
   4. Owner Witness: Perform tests in the presence of the Owners representative.
   5. Engineer Witness: The engineer or engineer's representative reserves the right to observe tests or selected tests to assure compliance with the specifications.
   6. Simultaneous Testing: Test observations by the Authority Having Jurisdiction (AHJ), the Owner's representative and the engineer's representative need not occur simultaneously.
   7. Do not perform testing, adjusting, and balancing work until plumbing equipment has been completely installed and is operating continuously as required.
   8. Conduct testing and balancing with clean filters in place. Clean strainers prior to performing testing and balancing.

9. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by AABC or NEBB.
10. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, controls Installer, and other support personnel. Provide 7 days advance notice of scheduled meeting time and location.
    a. Agenda Items: Include at least the following:
        1) Submittal distribution requirements.
        2) Testing, adjusting, and balancing plan.
        3) Work schedule and Project site access requirements.
        4) Coordination and cooperation of trades and subcontractors.
        5) Coordination of documentation and communication flow.
11. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
    a. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
    b. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
12. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing."
13. Testing, Adjusting, and Balancing Reports: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
14. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.
15. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
16. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.07 DEFINITIONS

A. Adjust: To regulate fluid flow rate at the equipment.

B. Balance: To proportion flows within the distribution system, including sub mains, branches, and terminals, according to design quantities.

C. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

D. Report Forms: Test data sheets for recording test data in logical order.

E. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

F. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

G. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

H. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

I. TAB: Testing and Balancing.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. Test: A procedure to determine quantitative performance of a system or equipment.

L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

M. AABC: Associated Air Balance Council.

N. AMCA: Air Movement and Control Association.

O. CTI: Cooling Tower Institute.

P. NEBB: National Environmental Balancing Bureau.

Q. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.08 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, controls installers, and other mechanics to operate systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on piping distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 PROJECT CONDITIONS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

B. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

C. Non-Owner Occupancy: Complete balancing of building systems prior to Substantial Completion and owner occupancy.

3.02 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and existing building record documents (if available) to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
   1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
   2. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of Plumbing systems and equipment.

C. Examine equipment performance data including pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

D. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

E. Examine system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings

are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

G. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.

H. Examine equipment for installation and for properly operating safety interlocks and controls.

I. Examine automatic temperature system components to verify the following:
   1. Valves, and other controlled devices operate by the intended controller.
   2. Valves are in the position indicated by the controller.
   3. Integrity of valves for free and full operation and for tightness of fully closed and fully open positions.
   4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
   5. Sensors are located to sense only the intended conditions.
   6. Sequence of operation for control modes is according to the Contract Documents.
   7. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.

J. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

K. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete.
   2. Systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Isolating and balancing valves are open and control valves are operational.

C. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Attendance is required by installers whose work will be tested, adjusted, or balanced.

D. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

3.04 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation for pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including control positions, valve indicators and similar controls and devices, to show final settings.

3.05 ADJUSTMENT TOLERANCES

A. Piping Systems: Adjust to within plus or minus 10 percent of design.

3.06 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   3. Contract interpretation requests.

4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on drawings locations where other critical measurements were taken and cross reference location in final report.

3.07 FUNDAMENTAL PROCEDURES FOR PIPING SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 10 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
1. Open manual valves for maximum flow.
2. Check expansion tank liquid level, or air charge if bladder type.
3. Check makeup-water-station pressure gauge for adequate pressure.
4. Check flow-control valves for specified sequence of operation and set at design flow.
5. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

3.08 FINAL REPORT

A. General: Computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into Sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:
1. Pump curves.
2. Field test reports prepared by system and equipment installers.
3. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
1. Title page.
2. Name and address of testing, adjusting, and balancing Agent.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of testing, adjusting, and balancing Agent who certifies the report.
10. Summary of contents, including the following:
    a. Design versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
11. Nomenclature sheets for each item of equipment.
12. Notes to explain why certain final data in the body of reports vary from design values.

E. Pump Test Reports: For pumps, include the following data. Calculate impeller size by plotting the shutoff head on pump curves.
1. Unit Data: Include the following:
    a. Unit identification.

b. Location.
c. Service.
d. Make and size.
e. Model and serial numbers.
f. Water flow rate in gpm (L/s).
g. Water pressure differential in feet of head or PSIG (kPa).
h. Required net positive suction head in feet of head or PSIG (kPa).
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.

END OF SECTION

SECTION 22 0700
PLUMBING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Type 1, Fiberglass Pipe Insulation
   2. Type 4, Cellular Glass
   3. Type 5, Fiberglass Equipment Insulation
   4. Type 7, ADA Accessible Lavatory/Sink Insulation Kit
   5. Jacketing
   6. Accessories
   7. Pipe Fitting Insulation Covers

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Piping insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Installer qualifications.
   2. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
   3. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.
   4. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.
   5. Submit manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements apply to this Section.

B. In addition, meet the following:
   1. Installer to have minimum 5 years experience in the same business.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.07 FIRE HAZARD CLASSIFICATION

A. Maximum fire hazard classification of composite insulation construction as installed to be not more than a flame spread of 25, fuel contribution of 50 and smoke development of 50 as tested by ASTM E84 (NFPA 255) method.

B. Test pipe insulation in accordance with requirements of UL "Pipe and Equipment Coverings".

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General:
   1. Armacell LLC Armaflex
   2. Certainteed
   3. Johns Manville
   4. Knauf
   5. Owens-Corning
   6. PPG
   7. Or approved equivalent.

B. Type 7, ADA Accessible Lavatory/Sink Insulation Kit:
   1. IPS/Truebro
   2. McGuire/Pro-Wrap
   3. Plumberex/Pro-Extreme
   4. Brocar Trap Wrap
   5. Or approved equivalent.

2.02 TYPE 1 FIBERGLASS PIPE INSULATION

A. Glass Fiber: ASTM C547; rigid molded, noncombustible.
   1. Thermal Conductivity Value: 0.27 BTU*in/(hr*sf*F) at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Vapor Retarder Jacket: White Kraft paper reinforced with glass fiber and bonded to aluminum foil, with self sealing longitudinal laps and butt strips or vapor barrier mastic.

2.03 TYPE 4, CELLULAR GLASS

A. Cellular Glass Insulation: Pittsburgh Corning foamglass pipe insulation fabricated in accordance with ASTM C552 and C585. Thermal conductivity of 0.33 BTU*in/(hr*sf*F) at 50 degrees F.

2.04 TYPE 5, FIBERGLASS EQUIPMENT INSULATION

A. Flexible Fiberglass Blanket: ASTM C612; flexible.
   1. Thermal Conductivity Value: 0.24 BTU*in/(hr*sf*F) at 75 degrees F.
   2. Maximum Service Temperature: 450 degrees F.

2.05 TYPE 7, ADA ACCESSIBLE LAVATORY/SINK INSULATION KIT

A. P-traps, trap arms, tail pieces, hot water and cold water insulating guards. Molded closed cell insulation with vinyl cover and nylon fasteners, paintable. Thermal conductivity; K = 1.17 (BTU*in/(hr*sf*F) at 75 degrees F mean temperature. Provide accessories as required for complete installation covering all exposed waste piping, water piping, stops and supplies. Color white.

2.06 JACKETING

A. Canvas Jacket: UL listed fabric, 6 oz/sq.yd., plain weave cotton treated with dilute fire retardant lagging adhesive.

B. Aluminum Jacket: 0.016-inch-thick sheet, embossed finish, with longitudinal slip joints and 2-inch laps, die-shaped fitting covers with factory attached protective liner. ASTM B 209.

C. Stainless Steel Jacket: Type 304 stainless steel, 0.010-inch, smooth finish. ASTM A 666

2.07 ACCESSORIES

A. Equipment Insulation Jacketing: Pre-sized glass cloth, not less than 7.8 ounces/sq.yd., except as otherwise indicated. Coat with gypsum based cement.

B. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

C. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have same flame and smoke component ratings as insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide non-water soluble treatments. Provide UV protection recommended by manufacturer for outdoor installation.

2.08 PIPE FITTING INSULATION COVERS

A. PVC Plastic Fitting Covers: Schuller Zeston 2000, Knauf Proto Fitting or approved equivalent. One-piece molded type fitting covers and jacketing material, gloss white. Connections: Tacks; pressure sensitive color matching vinyl tape.

PART 3 - EXECUTION

3.01 VERIFICATION OF CONDITIONS

A. Do not apply insulation until pressure testing of piping has been completed. Do not apply insulation over heat tracing until system tested. Do not apply insulation until piping has been inspected.

B. Examine areas and conditions under which insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and dry surfaces to be insulated.

3.03 INSTALLATION

A. Insulation: Continuous through walls, floors and partitions supports and hangers except where noted otherwise.

B. Piping and Equipment:
   1. Install insulation over clean, dry surfaces with adjoining Sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until piping has been leak tested and has passed such tests. Do not insulate manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.
   2. Cover insulation on pipes above ground, outside of building, with aluminum jacketing. Position seam on bottom of pipe.

3.04 PROTECTION AND REPLACEMENT

A. Protect installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

3.05 FIBERGLASS INSULATION

A. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.

B. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use preformed PVC molded insulation covers.

3.06 LABELING AND MARKING

A. Provide labels, arrows and color coding on piping. Attach labels and flow direction arrows to jacketing per Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.07 PIPING SURFACES TO BE INSULATED

Item to be Insulated	System Insulation Type	Pipe Size	Insulation Thickness
Hot Water Piping Above Grade	1	Runouts up to 1-1/2-inch Mains=<1-1/2-inch Mains >1-1/2-inch	1-inch 1-inch 1-1/2-inch
Hot Water Circulation Piping Above Grade	1	Runouts, up to 1-1/2-inch Mains =<1-1/2-inch Mains >1-1/2-inch	1-inch 1-inch 1-1/2-inch
Domestic Cold Water Except Minor Branch Piping Within Walls Serving Fixtures	1	=<1-1/2-inch >1-1/2-inch	1/2-inch 1-inch
Hot Water and Grease Waste Piping Below Grade	4	=<1-1/2-inch > 1-1/2-inch	1-inch 1-1/2-inch
Domestic Water Piping Exposed to Weather	1, 4	All	1-1/2-inch
Piping with Heat Tracing	1, 4	=<1-1/2-inch > 1-1/2-inch	1-inch 1-1/2-inch
Rain Conductors all Above Grade Piping	1	All	1/2-inch
Roof Drain Underbodies	5	N/A	1-inch
Overflow Roof Drain Underbodies	5	N/A	1-inch
ADA Accessible Lavatory/Sink	7	All	As Listed
Condensate Drain Piping	1	All	1/2-inch

3.08 ROOF DRAIN/OVERFLOW DRAIN UNDERBODIES AND PIPING

A. Above grade, cover all roof drain piping and overflow drain piping with Sectional pipe covering. Cover underside of drain body with insulation; attached with adhesive and supported externally with 26 gauge galvanized flat strapping anchored to structure.

3.09 ADA ACCESSIBLE LAVATORIES/SINKS

A. Provide lavatory/sink insulation kit. Install on waste fittings, hot and cold water stops and supplies. Install per manufacturers requirements.

3.10 INSULATED PIPE EXPOSED TO WEATHER

A. Where piping is exposed to weather, cover insulation with aluminum jacket. Seal watertight jacket per manufacturer's recommendations. Install metal jacket with 2-inch overlap at longitudinal and butt joints with exposed lap pointing down. Secure jacket with stainless-steel draw bands 12-inches on center and at butt joints. Provide heat tracing on piping subject to freezing. See Section 22 05 33, Heat Tracing for Plumbing Piping.

3.11 FOAMGLASS INSULATION

A. Install in accordance with manufacturer's instructions for below grade installation.

3.12 INSULATION SHIELDS

A. Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation Section at insulation shields for lines 1-1/2-inches and larger (hot and cold piping).

B. Install in accordance with manufacturer's instructions for below grade installation.

END OF SECTION

SECTION 22 1000
PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. General
   2. Sanitary, Drainage (Rain/Stormwater) DWV Piping, Buried Within 5-feet of Building
   3. Sanitary, Drainage (Rain/Stormwater) DWV Piping, Above Grade
   4. Water Piping, Buried Within 5-feet of Building
   5. Hot and Cold Domestic Water Above Grade
   6. Condensate Piping
   7. Primer Piping
   8. Flanges, Unions, and Couplings
   9. Ductile Iron Pipe and Fittings
   10. Polypropylene Pipe (PP-R), Fittings and Valves
   11. CPVC (Chlorinated Poly Vinyl Chloride) Pipe and Fittings
   12. Piping Specialties
   13. Cleanouts

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. NSF 61, Annex G

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Uponor

B. Cerro

C. Dodge Phelps

D. Tyler

E. Charlotte

F. Elkhart

G. Enfield

H. Spears

I. Nibco

J. Aquatherm

K. Victaulic

L. or approved equivalent.

M. Cleanouts:
   1. J.R. Smith
   2. Zurn
   3. Wade
   4. Watts
   5. Or approved equivalent.

2.02 GENERAL

A. Provide pipe, tube and fittings of the same type, fitting requirements, grade, class and the size and weight indicated or required for each service, as indicated in other Division 22, Plumbing Specifications. Where type, grade, or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards.

B. Manufactured materials delivered, new to the project site and stored in their original containers.

C. Product Marking: Each item to be furnished with legible markings indicating: name brand and manufacturer, manufacturing process, heat number and markings as required per ASTM and UL/FM Standards.

D. Applicable Standards
   1. Steel pipe to conform to ASTM and ANSI Standards as specified in this Section.
   2. Copper piping to conform to ASTM B88, B306 and B208 and the standards of Copper Development Association (CDA), and American Welding Society, (AWS).
   3. Cast Iron Piping to conform to standards of ASTM A-74, CISPI 301 and FM 1680.
   4. Manufacturer's Standards Society (MSS) for valving and support reference standard.
   5. American Waters Association (AWWA) for Valving Assembly Standards.
   6. American Society of Sanitation Engineers (ASSE) for Valving Standards.
   7. American National Standards Institute (ANSI) for Piping Standards.
   8. NFPA Standard 51B - “Fire Prevention in Use of Cutting and Welding Processes”.
   9. Crosslinked polyethylene (PEX) pipe conforming to ASTM F876, F877 and CSA B1375, or DIN 16892 and 16893.

2.03 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, BURIED WITHIN 5-FEET OF BUILDING

A. Cast Iron Pipe: ASTM A 74 extra heavy weight hub and spigot.
   1. Fittings: Cast iron.
   2. Joints: Hub-and-spigot ASTM C564 neoprene gaskets and conform to ASTM C1563.

B. Cast Iron Pipe: ASTM A888/CISPI 301 hubless.
   1. Fittings: Cast iron.
   2. Coupling Assembly:
      a. Heavy Duty: ASTM C1540/SED4000, Clamp-All Hi-Torq 125 coupling. Husky SD 4000.

C. Copper Tube: ASTM B 306, DWV
   1. Fittings: ASME B16.29, wrought copper.
   2. Joints: ASTM B32, ASTM B-828 and NSF 61, Annex G alloy Sn50 solder.
   3. Flux: ASTM B813-91, water soluble.

D. PVC Pipe: ASTM D 2665 Schedule 40.
   1. Fittings: PVC DWV ASTM D2665.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.04 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74, extra heavy hub and spigot.
   1. Fittings: Cast iron.

2. Joint Seals: ASTM C564 neoprene gaskets and conform to ASTM 1563.

B. Cast Iron Pipe: ASTM A888/CISPI 301 hubless.
1. Fittings: Cast iron.
2. Coupling Assembly: Standard Duty ASTM C1277 or CISPI 301. Anaco, Mission, Tyler.

C. Copper Tube: ASTM B 306, DWV
1. Fittings: ASME B16.29, wrought copper.
2. Joints: ASTM B32, alloy Sn50 solder.

D. PVC Pipe: ASTM D2665 Schedule 40.
1. Fittings: PVC DWV ASTM D2665.
2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.05 WATER PIPING, BURIED WITHIN 5-FEET OF BUILDING

A. Copper Pipe: ASTM B88, hard drawn, Type K (A).
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
2. Joints: Brazed - BCuP2.

B. Ductile Iron Pipe: AWWA C151/A21.51.
1. Fittings: Ductile or gray iron, standard thickness.
2. Joints: AWWA C111/A21.11, rubber gasket with 3/4-inch diameter rods.

2.06 HOT AND COLD DOMESTIC WATER ABOVE GRADE

A. Copper Tube: 3-inches and above. ASTM B88 (ASTM BA88m), Type L (B), Drawn.
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
2. Joints: Brazed BCuP2.

B. Copper Tube: 2-1/2-inches and smaller. ASTM B88 (ASTM B88M), Type L (B), Drawn.
1. Fittings: ASME B16.18 copper.
2. Joints: ASTM B32, alloy Sn95 solder.

C. Stainless steel roll grooved pipe: Water pressures up to 350 PSI gauge (3/4-inch threaded) stainless steel pipe, Schedule 10, conforming to ANSI AWWA-220 requirements.
1. Fittings: Type 316/316L Schedule 10s fittings conforming to ASTM A403.
2. Couplings: Type 316 stainless steel coupling conforming to ASTM A351 or ASTM A743.
3. Manufacturers: Victaulic or approved equivalent.

D. Cross-Linked Polyethylene Tubing, Fittings and Accessories (except exposed locations.)
1. Tubing - 1-inch and Smaller:
a. Cross-linked polyethylene (PEX) tubing complies with requirements of ASTM F876 and F877, and cross-lining method must be Type A (hot)method.
b. PEX tubing to have minimum working pressure of not less than 160 PSI for water at 73.4 degrees F, 100 PSI for water at 180 degrees F and 80 PSI for water at 200 degrees F determined in accordance with Plastic Pipe Institute Technical Report TR-3/92, and listed in Plastic Pipe Institute Technical Report TR-4/95.
2. Fittings:
a. Fittings: Engineered Plastic Fittings above grade applications. Engineered plastic fittings below grade applications. Serrated type with reinforcement rings.
b. Reinforcement Rings: Manufactured using "Engel Method" to ensure that viscoelastic stress regenerative properties are sufficient to produce pressure tight seal.
c. Fitting Insert: Of such dimension in that tubing must be expanded in order to facilitate insertion of fitting into tube.
d. Accomplish expansion of tubing and ring by an expansion tool designed expressly for that purpose.
e. Fittings complies with requirements of ASTM F877.
3. Manifolds: Provide premanufactured copper manifolds of same manufacturer as piping.
4. Stubout Ells and Stubout Brackets: Provide premanufactured Type L copper stubout ells and copper stubout brackets.

2.07 CONDENSATE PIPING

A. Copper Tube: ASTM B 88 (ASTM B898M), Type L (B)
   1. Fittings: ASME B16.29, wrought copper.
   2. Joints: ASTM B32, alloy Sn50 solder.

B. Piping for drainage of condensate from combustion fuel sources (such as condensing boilers and water heaters) is to be piping as noted in this Section for area of application.

2.08 PRIMER PIPING

A. Above Ground: Type L hard-drawn copper tubing with wrought sweat fittings and soldered joints.

B. Belowground: Type L soft annealed copper tubing with wrought sweat fittings and brazed joints.

C. Belowground: Cross-linked polyethylene (PEX) and engineered plastic fittings.

2.09 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3-inches and Under:
   1. Ferrous Pipe: Class 150 malleable iron threaded unions.
   2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 1-Inch:
   1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
   2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Dielectric Connections: Provide dielectric waterway or brass nipple fitting with threaded ends. Dielectric unions are not allowed.

2.10 DUCTILE IRON PIPE AND FITTINGS

A. Pipe: Class 52 ductile iron, ANSI A21.51, AWWA C1510-70, 150 PSI cement lined; factory encased with 8 mil polyethylene tube or sheet.

B. Fittings: ANSI A21.10 mechanical joint, AWWA C110-1971, 250 PSI. Fittings to be double field wrapped with 2-inch, 20 mil vinyl tape, 50 percent overlap, Scotch Wrap No. 51.

C. Fittings restrained with 2000 PSI thrust blocks in accordance with NFPA-24.

2.11 POLYPROPYLENE PIPE (PP-R), FITTINGS AND VALVES

A. Pipe: Manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of CSA B137.11 or ASTM F 2389. The pipe will contain no reworked or recycled materials except that generated in the manufacturer's own plant from resin of the same Specification from the same raw material. Piping to comply with the rated pressure requirements of ASTM F 2389. Pipe used for service temperatures 100 degrees F and higher to be manufactured with fiberglass reinforcement integral with the pipe.

B. Fittings: Manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings to contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same Specification from the same raw material. Fittings to be certified by NSF International as complying with NSF 14, NSF 61, Annex G and ASTM F 2389 or CSA B137.11.

C. Valves:
   1. Valves with PP-R bodies manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The valves to contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same Specification from the same raw material.
   2. Valves with brass bodies manufactured in accordance with the manufacturer's Specifications and be certified by NSF International as complying with NSF 61, Annex G.
   3. Approved Manufacturers: Aquatherm or Fusiotherm - Faser Composite Pipe SDR 7.4. The Engineer on the site can change the type of pipe to use depending upon the necessity and situation.

2.12 CPVC (CHLORINATED POLY VINYL CHLORIDE)PIPE AND FITTINGS

A. Pipe and Fittings: Schedule 40, NSF-14, ASTM 439, IAPMO IS20-96, socket fittings, solvent weld.
   1. For use with acidic condensate services only.

2.13 PIPING SPECIALTIES

A. Pipe Escutcheons:
   1. Provide pipe escutcheons as specified with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime zinc base paint finish for unoccupied areas.
   2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
   3. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.

B. Low Pressure Y-Type Pipeline Strainers:
   1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 percent of the working pressure of piping system with Type 304 stainless steel screens made with 8mm perforations at 233 perforations per square millimeter.
   2. Threaded Ends, 2-inch and Smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with plus.
   3. Flanged Ends, 2-1/2-inch and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with hose bibb.

C. Air Vent with Valves:
   1. Install automatic air vents in all closed and open-loop water systems at high points and at any other point necessary to free system of air. A shut-off valve to be provided in riser to each automatic vent valve to facilitate servicing. Manual type vent may be used in lieu of automatic type, where specifically shown on the Drawings.
   2. Manufacturer: Hoffman #79.

D. Dielectric Waterways:
   1. Provide standard products recommended by manufacturers in service indicated, which effectively isolate ferrous from non-ferrous piping (eliminating electrical conductance) to prevent galvanic action and stop corrosion.
   2. Provide dielectric waterways or brass nipple fitting for transitions between dissimilar metal piping.

E. Unions:
   1. Unions to comply with the following schedule:
      a. Black Steel, 2-inch and smaller: 150 PSI screwed malleable iron, ground joint, brass to iron seat.
      b. Black Steel, 2-1/2-inch and larger: 150 PSI cast iron screwed flanged, flat faced, full faced gasket.
      c. Soldered Copper or Brass Pipe, 2-inch and smaller: 150 PSI cast bronzed or copper, ground joint, non-ferrous seat with soldered ends.
      d. Screwed Copper or Brass Pipe, 2-inch and smaller: 150 PSI cast brass, ground joint, brass to brass seat, threaded ends.
      e. Flanged Copper or Brass Pipe, 2-1/2-inch and larger: Two 150 PSI cast bronze flanges.
      f. Manufacturer: EPCO, Mueller or Stanley G. Flagg or Watts or approved equivalent.

F. Flexible Piping Connectors - Expansion Loops or Seismic Joints:

1. Provide flexible expansion loops of size and material noted on Drawings. Flexible loops to be designed to impart no thrust loads on the anchors. The loop consists of two flexible Sections of hose and braid, two 90 degree elbows, and a 180 degree return. Loops to be installed in a neutral, precompressed, or preextended condition as required for the application. Loops installed hanging down to have a drain plug. Loops installed straight up may be fitted with an automatic air release valve to purge air from the high point of the loop. Loops installed in any position other than hanging down must have the 180 degree return supported.
2. Copper Pipe: Copper fittings, bronze hose and braid sweat solder ends, Metraloop Series MLS 8000.
3. Steel Pipe: Schedule 40 carbon steel fittings, stainless steel hose and braid,
4. Threaded Eds: Metraloop Series MLT 80000
5. Flanged Ends: Metraloop Series MLF 80000
6. Welded Ends: Metraloop Series MLW 80000
7. Grooved Ends: Metraloop Series MLG 80000
8. Gas Lines, CSA Approved: Metraloop - Gas MLT or MLF Series.
9. Vertical and horizontal straight run hot water and domestic hot water recirculation piping exceeding 1,000-feet to be provided with expansion joints by Mason, Flexionics or Shur Fit. Installation to be per manufacturer's installation directions.

2.14 CLEANOUTS

A. General: Locate cleanouts as shown on Drawings and as required by local code. Cleanouts same size as pipe except that greater than 4-inches will not be required. Plastic components not allowed, except unless specifically noted.

B. Types:
   1. Tile Floor Cleanouts: J. R. Smith 4020 with round heavy-duty nickel bronze top, taper thread, ABS plug and vandalproof screws.
   2. Carpeted Floor Cleanout: J. R. Smith 4020-X with carpet clamping frame 4023-Y, round heavy-duty nickel bronze top, taper thread, ABS plug, carpet clamping device and vandalproof screws.
   3. Concrete Floor Cleanout (General): J. R. Smith 4020 with round heavy-duty nickel bronze top, taper thread and ABS plug with vandalproof screws.
   4. Parking, Drives and Concrete Floor Cleanouts (Heavy Load): J. R. Smith 4100 with round heavy-duty nickel bronze top, taper thread and ABS plug with vandalproof screws.
   5. Wall Cleanout: J. R. Smith 4472-U, countersunk bronze taper thread plug, stainless steel shallow cover and vandalproof screws.
   6. Outside Area: J. R. Smith 4020-U with round heavy-duty nickel bronze top, taper thread, ABS plug and top secured with vandalproof screws. Install in 18- by 18- by 6-inch deep concrete pad flush with grade.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 INSTALLATION

A. Work performed by experienced journeyman plumbers. No exceptions.

B. Provide access panels for concealed valves, shock arrestors and trap primers.

C. Install pipes and pipe fittings in accordance with recognized industry practices.

D. Align piping accurately at connections, within 3/32-inch misalignment tolerance. Comply with ANSI B31 Code for Pressure Piping.

E. Locate piping runs, as indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and

its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2-inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1-inch clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view by locating it in column enclosures, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

1. Do not run piping through transformer vaults, telephone, elevator, electrical or electronic equipment spaces or enclosures.
2. Concealed Piping Above Suspended Ceiling: Plan and coordinate to avoid interferences; install to maintain suspended ceiling heights shown on Architectural Drawings. Allow sufficient space above removable ceiling panels for panel removal. Locate piping so that valves are visible and accessible within 24-inches horizontally and vertically from point of access to the ceiling space.
3. Exposed Work: Run pipes parallel to the closest wall unless otherwise shown on Drawings; maintain maximum headroom; avoid light fixtures.
4. Insulation Space Allowance: In piping work, allow space for pipe insulation and jackets. If interferences occur, move the piping to accommodate insulation thickness specified.
5. Pipe Lengths: Do not use short lengths or nipples at locations where a full length of pipe will fit.
6. Alignment Prior to Supporting and Anchoring: Place piping in proper alignment and position prior to connection to anchors, expansion loops, and equipment. Furnish jacking devices, temporary steel structural members, and assembled structures as necessary. Remove temporary equipment and structures supplied by contractor at completion; such items to remain Contractor property.
7. Valve and Equipment Connections: Piping not to place undue stress on flanged valves and equipment connections. Mating flange faces to be true and parallel to each other and not to require springing of piping for assembly. Pipe hangers and supports to carry the full weight of the pipe and fluid.
8. Piping Leaks: Correct immediately; use new materials; leak-sealing compounds or peening not permitted.
9. Pressure Ratings of Fittings, Valves, and Devices in Piping Systems: Pressure rating to be equal to or greater than the maximum working pressure of the system.
10. Equipment Vents and Drains: Provide for coils and vessels which contain water. Provide isolation valves and outlet valves at piping high and low points to permit venting and draining of the vessel without venting and draining connected piping. Provide hose connections and caps on drain lines.
11. Escutcheon Plates: Where exposed insulated and uninsulated piping passes through walls, floors or ceilings; provide spring clip type. Provide plates on both sides of wall or floor.

3.03 PIPE JOINTS

A. Piping to be cut squarely, free of rough edges and reamed to full bore. Piping to be fully inserted into fittings.

B. Provide joints of type indicated in each piping system.

C. Thread pipe in accordance with ANSI/ASME B1.20.1 Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

D. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM std. B-32, in accordance with IAPMO Is 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints to be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes to be water soluble for copper and brass potable water applications, and meets CDA standard test method 1.0 and ASTM

B813-91. Solder to be applied until a full fillet is present around the joint. Solder and flux not to be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosion flux not to be present at the jobsite.

E. Braze copper tube and fitting socket with BCUP series filler metal without flux. Listed brazing flux to be used for joining of copper tube to brass or bronze fittings and will meet AWS FB3A or FB3C. "Shock" cooling is prohibited. a continuous fillet is to be visible around the completed joint. After cooling, flux residue to be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10 percent nickel. Piping is to be capped or plugged during construction to prevent entry of foreign material.

F. Cast-Iron Joints: Comply with coupling manufacturer's Cast Iron Soil Pipe Institute Standards and installation instructions.

G. Welders performing work under this Contract to be certified and qualified in accordance with tests prescribed by the National Certified Welding Bureau (NCWB) or by other approved test procedures using methodology and procedures covered in the ASME Boiler and Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators". Installation to conform to ANSI 31.1 "Power Piping".
   1. Submit for approval the names, identification, and welder's assigned number, letter or symbol for welders assigned to this project.
   2. The assigned identification symbol to be used to identify the work of each welder and to be indelibly stamped immediately upon completion of each weld.
   3. Welders to be tested and certified for all positions.
   4. Submit identifying stenciled test coupons made by each operator.
   5. Welders may be required to retake welding certification tests without additional expense.
   6. When so requested, a welder will not be permitted to work as a welder on this project until he has been recertified in accordance with NCWB.
   7. Recertification of the welder to be made after the welder has taken and passed the required tests.

H. Weld pipe joints in accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0F.
   2. Bevel pipe ends at a 37.5 degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
   3. Use pipe clamps or tack-weld joints with 1-inch long welds, 4 welds for pipe sizes to 10-inches, 8 welds for pipe sizes 12-inches to 20-inches.
   4. Build up welds with a stringer-bead pass, followed by a hot pass, followed by a cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
   5. Do not weld out piping system imperfections by tack-welding procedures. Re-fabricate to comply with requirements.
   6. At Installer's option, install forged branch-connection fittings whenever branch pipe is indicated, or install a regular T-fitting.

I. Flanges:
   1. Provide flanges at steel or copper piping, valves and equipment, sizes 2-1/2-inches or larger, unless specified otherwise; weld neck or slip-on pattern.
   2. Bolts: Provide studs (both ends threaded) with hexagon nuts where necessary to facilitate removal of valves or disassembly of flanged systems.
   3. Dielectric Flanged Insulation: Provide on dissimilar metal flanged piping connections.

3.04 SANITARY AND STORM SEWER

A. Piping to be graded at a uniform pitch of 2 percent unless otherwise noted on Drawings.

B. Indirect Waste or Drain Piping: Extend piping to discharge as shown on Drawings. Maintain minimum air gap. Provide traps on direct waste or drain piping exceeding 60-inches.

C. Fixture Carriers: Concealed fixture carriers for wall mounted plumbing fixtures are specified in Section 22 40 00.

D. Drains:
   1. Install drains to suit finished floor or roof surface. Install drains and components per manufacturer's instructions. Arrange for flooring to be sloped to floor drain or sink a minimum of 1/2-inch below finished floor elevation.
   2. Install P-traps for hub drains, floor drains and floor sinks. P-traps to be of the same materials as soil and waste piping. Provide trap primer assembly for each drain or floor sink.

E. Wall Access Panel: Secure to wall framing and install so that flange forms a close fitting joint with the finished wall surface.

F. Heat trace and insulate P-traps exposed to freezing conditions.

G. Insulate horizontal branch lines from floor sinks, receptors and drains receiving cold discharge from equipment and appliances.

3.05 DOMESTIC WATER

A. "Piping" to include pipes, fittings, nipples, valves and accessories connected thereto.

B. Run piping generally parallel to the axis of the building, arranged to conform to the building requirements and to suit the necessities of clearance for other mechanical ducts, flues, conduits and work of other trades, and as close to ceiling or other construction as practical, free of unnecessary traps or bends.

C. Grade water supply piping for complete drainage of the system. Install hose bibbs at low points.

D. Piping connections to equipment to be made up with unions.

E. Provide sufficient elbows, swings and offsets to permit free expansion and contraction.

F. Use reducers or increasers. Use no bushings.

G. Ream or file each pipe to remove burrs. Inspect each length of pipe and each fitting for workmanship and clear passageways.

H. Cover, cap or otherwise protect open ends of piping during construction to prevent damage to threads or flanges and prevent entry of foreign matter. Disinfect and sterilize water supply piping as specified. Furnish written report on final water quality results.

I. Exposed connections to equipment to be installed with special care, showing no tool marks or threads at fittings and piping. No bowed or bent piping to be permitted.

J. Ferrous to non-ferrous connections to be made by means of dielectric fittings.

K. Use extra heavy pipe for nipples, where unthreaded portion is less than 1-1/2-inches. Use no close nipples. Use only shoulder-type nipples.

L. Through-Wall Pipes: Type 'L' copper tubing for through-wall pipes which connect to exposed stops at wall surface. Anchor the pipes in the wall; attach pipe with U-bolts to steel back-up plates or steel angles anchored in the wall. Provide wrought copper elbow which securely anchors ears in wall at through-wall pipes.

M. Provide drain valves at base of risers and at low points on the system.

N. Backflow Preventers: Pipe relief to nearest drain. Slope at 2 percent.

3.06 SLEEVES

A. Pipe Sleeves:
   1. Layout work in advance of pouring concrete, furnish, and set sleeves necessary to complete work.
   2. Floor Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1-inch above finished floor. Caulk pipes passing through floor with non-shrinking grout or approved caulking compound (Except DWV Piping penetrating a concrete Slab set on Finish Grade), provide "Link-Seal" sleeve sealing system for

concrete/slab penetrations which are below grade. Caulk/seal piping passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements

3. Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with non-shrinking caulking compound. Provide modular link sealing system for concrete penetrations which are below grade. Caulk/seal piping passing through fire-rated assemblies per local AHJ requirements.
4. Beam Sleeves: Coordinate with trades for locations of pipe sleeves in reinforced concrete and steel beams. Indicate penetrations on structural shop drawings. See Drawings and Specifications for specific sleeve location limitations. Plumbing Drawings are diagrammatic. Offset piping as required to meet these limitations. Pipe sleeve locations must be indicated on reinforced concrete and steel beam shop drawings. Field cutting of beams not allowed without written approval of structural engineer. No extra costs allowed for failure to coordinate beam penetrations prior to reinforced concrete and steel beam shop drawing submittal.

B. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
   1. Install fabricated pipe sleeve.
   2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve I.D.
   3. Seal each end airtight with a resilient nonhardening seal per code.

C. Piping penetrations through fire-rated (1 to 3 hour) assemblies:
   1. Select and install pre-engineered pipe penetration system in accordance with UL listing and manufacturer's recommendation.
   2. Reference Division 7.
   3. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E84.

3.07 EXCAVATION AND BACKFILL

A. Excavate and backfill in accordance with Division 31. Otherwise, provide the following:
   1. Trenching, bedding and backfill to meet the requirements of the Project Geotechnical Report. The standards listed below are a minimum.
   2. Native soils may not be used for bedding or pipe zone backfill without specific approval of the Project Geotechnical Consultant.
   3. General: Perform necessary excavation and backfill required for installation of plumbing work. Repair piping or other work at no expense to Owner.
   4. Water: Keep excavations free of standing water. Reexcavate and fill back excavations damaged or softened by water or frost to original level with sand, crushed rock or other approved material at no expense to Owner.
   5. Tests: During progress of work for compacted fill, Owner reserves right to request compaction tests made under direction of testing laboratory.
   6. Trench Excavation: Excavate trenches to necessary depth and width, removing rocks, unstable soil (muck, peat), roots and stumps. Excavation material is classified as "base fill" and "native." Base fill excavation material consisting of placed crushed rock may be used as backfill above "Pipe Zone." Remove and dispose off site native excavation material. Adequate width of trench for proper installation of piping or conduit.
   7. Support Foundations:
      a. Foundations: Excavate trenches located in unstable ground areas below elevation required for installation of piping to depth which is determined by Architect as appropriate for conditions encountered. Place and compact approved foundation material in excavation up to "Bedding Zone." Dewatering, placement, compaction and disposal of excavated materials to conform to requirements contained in other Sections of Specifications or Drawings.

b. Over-Excavations: Where trench excavation exceeds required depths, provide, place and compact suitable bedding material to proper grade or elevation at no additional cost to Owner.
c. Foundation Material: Where native material has been removed, place and compact necessary foundation material to form base for replacement of required thickness of bedding material.

	Class A		Class B	
Material Passing	Min.	Max.	Min.	Max.
3/4-inch Square Opening	27	47	0	1

d. Bedding Material: Full bed piping on sand, pea gravel, or 3/4-inch minus crushed rock. Place minimum 4-inch deep layer of sand, pea gravel, or crushed rock on leveled trench bottom for this purpose. Remove bedding to necessary depth for piping bells and couplings to maintain contact of pipe on bedding for its entire length. Provide additional bedding in excessively wet, unstable, or solid rock trench bottom conditions as required to provide firm foundation.

8. Backfilling:
   a. Following installation and successful completion of required tests, backfill piping in lifts.
      1) In "Pipe Zone" place backfill material and compact in lifts not to exceed 6-inches in depth to height of 12-inches above top of pipe. Place backfill material to obtain contact with entire periphery of pipe, without disturbing or displacing pipe.
      2) Place and compact backfill above "Pipe Zone" in layers not to exceed 12-inches in depth.
   b. Backfill Material:
      1) Backfill Material in "Pipe Zone": 3/4-inch minus crushed rock, sand or pea gravel.
      2) Crushed rock, fill sand or other backfill material approved elsewhere in Specifications may be used above "Pipe Zone."
9. Compaction of Trench Backfill:
   a. Where compaction of trench backfill material is required, use one of following methods or combination thereof:
      1) Mechanical tamper,
      2) Vibratory compactor, or
      3) Other approved methods appropriate to conditions encountered.
   b. Architect to have right to change methods and limits to better accommodate field conditions. Compaction sufficient to attain 95 percent of maximum density at optimum moisture content unless noted otherwise on Drawings or elsewhere in Specifications. Water "puddling" or "washing" is prohibited.

3.08 TESTING

A. General:
   1. Provide temporary equipment for testing, including pumps, compressors, tanks, and gauges, as required. Test piping systems before insulation (if any) is installed and remove or disengage control devices before testing. Where necessary, test Sections of each piping system independently, but do not use piping valves to isolate Sections where test pressures exceed local valve operating pressure rating. Fill each Section with water, compressed air, or nitrogen and pressurize for the indicated pressure and time.
   2. Notify Architect and local Plumbing Inspector 2 days before tests.
   3. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head.

System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in Sections if minimum head cannot be maintained in each Section. 5 PSI head to be minimum pressure at highest joint.

4. Water Piping: Eliminate air from system. Fill and test at 125 PSIG or minimum 1-1/2 times static pressure at connection to serving utility main for period of two hours with no loss in pressure.
5. Send test results to Architect for review and approval.

B. Testing of Pressurized Systems:
   1. Test each pressurized piping system at 150 percent of operating pressure indicated, but not less than 125 PSIG test pressure.
   2. Observe each test Section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 2 percent of test pressure.

C. Test hot and cold domestic water piping systems upon completion of rough-in and before connection to fixtures at hydrostatic pressure of 125 PSIG.

3.09 STERILIZATION OF DOMESTIC WATER SYSTEM

A. General: Upon completion of tests and necessary replacements, thoroughly flush and disinfect domestic water piping.

B. Method: After thoroughly flushing system with water to remove sediment, fill system with a solution containing 50 parts per million of chlorine for not less than 24 hours or 200 parts per million of chlorine for not less than 3 hours. After retention, drain, reflush and return system to service.

C. Certification: Provide copy of domestic water chlorination certificate in each operations and maintenance manual.

D. Provide water line disinfections performed by a licensed contractor with training in potable water line disinfections.

3.10 CORROSIVE SOIL CONDITIONS

A. Wrap steel, iron, copper or other metal piping materials/fittings with Protecto Wrap 200, 30 mils or greater. Maintain a 1/2-inch overlap and install per manufacturer's requirements.

3.11 PROTECTION

A. Keep pipe openings closed by means of plugs or caps to prevent entrance of foreign matter. Protect piping, ductwork, fixtures, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore to its original condition or replace fixtures, equipment or apparatus damaged prior to final acceptance of work.

3.12 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

A. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.

B. Manufacturers: Hilti and Proset.

3.13 CLEANOUTS

A. Install in aboveground piping and building drain piping as indicated, as required by code; at each change in direction of piping greater than 135 degrees; at minimum intervals of 100-feet; and at base of each vertical soil or waste stack. Install floor and wall cleanout covers for concealed piping. Select type to match adjacent building finish. Provide shop drawings to Architect to coordinate locations and types of cleanouts with Architect prior to installation.

END OF SECTION

SECTION 22 1415
RAINWATER HARVEST SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
1. Non Potable Water Piping
2. General Drain Piping
3. Pump Pressure Piping
4. Valves
5. Globe Valves
6. Drain Valves
7. Ball Valves
8. Butterfly Valves
9. Swing Check Valves
10. Lift Check Valves
11. Water Hammer Arrestors (Shock Absorbers)
12. Thermometers
13. Pressure Gauges
14. Single-Stage Bag Filter Assembly
15. Water Booster Pumps
16. Well Pumps
17. ASME Hydro-Pneumatic Bladder Tanks
18. Ultraviolet Sterilizers
19. Smoothing Inlet Fitting
20. FRP Storage Tanks - Below Grade Installations
21. Pressure Switches
22. Float Switches
23. Aeration System for Cisterns
24. Priming Fill Valve
25. Rainwater Day Tank (RST-1)
26. Dissolved Oxygen Sensor and Panel (DOS-1)

B. Manufacturers: Firms regularly engaged in manufacture of plumbing system products, of types, materials, and sizes required.

1.02 RELATED SECTIONS

A. Contents of Division 22 and Division 01, General Requirements apply to this Section.

B. In addition:
1. Furnish and install access doors/panels required for the work of this Section. Confirm requirements for access doors/panels in Division 08, Openings and Section 22 00 00, General Plumbing Requirements.
2. Furnish and install sleeves, inserts and anchorage required for the installation, which are embedded in work of other trades. Sleeve, wrap and seal piping in concrete.
3. Electrical: For plumbing trim/devices/ equipment, provide, from the 120-volt connection by Division 26, the low voltage electrical connections and wiring as required for complete and operable system. Includes, but is not limited to low voltage electrical raceway, wiring and accessories, such as step-down transformers as necessary for function of sensors and automatic valve and faucet controls. Supply step-down transformers and size wiring as recommended by manufacturer of plumbing trim/faucets requiring electrical low voltage connection.
4. Fixtures, Equipment, Devices:
   a. Fixtures, equipment, devices and trim as shown on Drawings.
   b. Appurtenances for equipment and devices.

c. Rough and final connection to equipment and fixtures, relocated or provided under other sections by Owner and under other divisions of the work.
d. Standards and supports for equipment requiring them.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00 and Division 01, General Requirements.

B. In addition, meet the following:
1. For Design/Build Rainwater Harvesting Systems: State of Oregon Building Codes Division, Alternate Method Ruling No. OFSC 08-03, Rainwater Harvesting System for Providing Water for Non-Potable Uses.
2. State of Oregon Building Codes Division, Alternate Method Ruling No. OPSC -8-04 Rainwater Harvesting System for Providing Water for Flushing Toilets and Urinals.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00 and Division 01, General Requirements.

B. In addition, provide:
1. Product data for Manufacturer's Specifications, installation and startup instructions, capacity and ratings, with selection indicated. Provide pump performance curves with selection points indicated. Provide specialties and accessories required for a complete and operable installation.
2. Shop Drawings: Provide assembly type Shop Drawings indicating dimensions, weights, required clearances, and methods of assembly of components and anchorages.
3. Wiring Diagrams: Ladder type wiring diagrams for components, indicating required field electrical connections.
4. Maintenance Data: Submit maintenance data and parts list for each item. Include "troubleshooting" maintenance guides. Include this data in operation and maintenance manual.
5. LEED Submittals: Credit EQc4.1 - Adhesives and Sealants LEED Product Information Form and Product Sheets, reference Section 1115.
6. Provide design/build services for low voltage and control wiring and systems as required for devices, equipment, etc. in the Contract Documents. Submit product cut sheets together with shop drawings indicating electrical connection schematics, location of equipment, devices and appurtenances.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00 and Division 01, General Requirements.

B. In addition, meet the following:
1. FRP Storage Tanks, Below Grade: Tank manufacturer to manufacture tanks to Underwriters Laboratories (UL) Standard 1316.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00 and Division 01, General Requirements.

1.07 PLUMBING FIXTURES, EQUIPMENT AND DEVICES

A. General: Provide factory fabricated fixtures of type, style and material indicated on the plumbing fixture connection schedule on the Drawings. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by manufacturer, and as required for complete installation. Where more than one type is indicated, selection is installer's option; but, fixtures of same type must be furnished by a single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.
1. Fixtures: Complete with fittings, supports, fastening devices, valves, traps, stops and appurtenances required.
2. Escutcheons: Brass, chrome plated.

3. Stops: Stops installed in each supply pipe at each device accessibly located.
4. Supplies: Stainless steel braided flexible tubing, NSF listed for potable water applications with factory-fabricated stainless steel connectors.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. WISY AG
B. Rainwater management Systems (RMS)
C. Siemens Water Technology
D. Highland Tank
E. Water Control Corporation
F. Weil Pump
G. Goulds Pump
H. Grundfos Pump
I. Jensen Instrument
J. BRAE
K. Or approved equivalent.

2.02 NON POTABLE WATER PIPING

A. Above Ground: Type “L” copper tubing. Wrought copper or cast bronze sweat fittings.
   1. Piping 3-Inches and Above: Brazed.
   2. Piping 2-1/2-inches and Smaller: Soldered (95/5 solder) joints.
   3. Approved Fillers:
      a. Pressure Range 81 to 150 PSI and Temperatures 151F to 200F: 95/5 tin-antimony or silver-bearing solders, i.e., Allstate 430, Harris Stay Brite 5 or 8.
      b. Use appropriate flux per manufacturer's recommendations. Use of corrosive fluxes is prohibited.

B. Belowgound: Type "K" copper tubing with brazed joints. Approved Fillers: "Phos-0," "Silfos 5," "Aircosil 15," "Braze 450(DE)." Use appropriate flux per manufacturer's recommendations.

C. Polypropylene - Non-Potable Water Piping (Purple):
   1. Piping:
      a. Pipe manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11. The pipe contains no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. Pipe to comply with the rated pressure requirements of ASTM F 2389 or CSA B137.11. Pipe certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.
      b. Pipe will be Aquatherm® Lilac® available from Aquatherm, Inc.
   2. Fittings:
      a. Fittings manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. Fittings are certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.
      b. Provide fittings by Aquatherm® Greenpipe® available from Aquatherm, Inc.
   3. Warranty:
      a. Manufacturer warrants pipe and fittings for 10 years to be free of defects in materials or workmanship.
      b. Warranty covers labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or workmanship.
   4. Smoke and Fire Ratings:

a. Where a Plenum-rated Piping System is needed, provide pre-insulated pipe or field insulated, and when tested with standard un-insulated fittings per CAN/ULC-S102.2-03 or ASTM E84, the system consisting of wrapped or coated pipe and bare fittings to have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.
b. Provide Aquatherm® Advanced Lilac® Pipe (wrapped and insulated) available from Aquatherm, Inc.

5. UV Protection:
   a. Where the pipe will be exposed to direct UV light for more than 30 days, provide pipe with a Factory applied, UV-resistant coating or alternative UV protection.
6. Color and Marking of Pipe:
   a. Harvested water pipe is marked with “CAUTION: NON-POTABLE RECYCLED / RECLAIMED WATER, DO NOT DRINK” at intervals not to exceed one meter.
   b. Water pipe is manufactured with purple color integral to the pipe

2.03 GENERAL DRAIN PIPING

A. Type "L" copper tubing and wrought copper or cast bronze sweat fittings. 95/5 soldered joints. On sizes 1-1/4-inches and larger, provide "DWV" pattern drainage fittings.

2.04 PUMP PRESSURE PIPING

A. Above Grade: Type "L" copper with solder joints.

B. Below Grade: Type "L" copper with brazed joints.

2.05 VALVES

A. General:
   1. End Connections: Mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is installer's option.
   2. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe sizes.
   3. Reference Section 22 05 23, General-Duty Valves for Plumbing Piping for detailed valve specifications.

B. Service:
   1. Non Potable Water Shutoff and Isolation Valves:
      a. Pipe Sizes 3-inches and Smaller: Ball valve.
      b. Pipe Sizes 4-inches and Larger: Butterfly valve.
   2. Drain Service; All Pipe Sizes: Drain valves.
   3. Strainer Blow-Off: Ball valve.
   4. Bypass Around Pressure-Reducing Valves: Globe valves.
   5. Check Valves Other than Pump Discharge: Swing check.
   6. Relief Valve: ASME code approved pressure and temperature relief valve. Run full size pipe to floor drain, or as noted otherwise. Cash-Acme, Watts, or approved equivalent.

2.06 GLOBE VALVES

A. 2-inches and Smaller: Class 150, bronze body, screw-in bonnet, integral seat, renewable disc, straight body, Nibco 235.

B. 2-1/2-inches and Larger: Class 250, iron body, bolted bonnet, flanged ends, renewable seat and disc, bronze mounted. Straight Body: Nibco F-768-B. Angle Body: Nibco F-869-B.

2.07 DRAIN VALVES

A. Class 125, bronze body, screw-in bonnet, rising stem, composition disc, 3/4-inch hose outlet. Threaded: Nibco 73. Solder: Nibco 72.

2.08 BALL VALVES

A. 2-1/2-inches and Smaller: 150 PSI, bronze body, full port, bronze trim, three piece construction, TFE seats and seals. Threaded: Nibco T-595-Y. Soldered: Nibco S-595-Y.

B. 3-Inches and Larger: 150 PSI, cast-iron body, full port, two-piece body, TFE seats with stainless steel ball. FDA rated for potable water. Flanged Connection: Watts G4000.

2.09 BUTTERFLY VALVES

A. Select lug type valves.

B. 4-Inches and Smaller: 200 PSI, ductile iron body, extended neck, aluminum bronze disc, reinforced resilient EDPM seat, manual lever and lock. Nibco LD2000-3.

2.10 SWING CHECK VALVES

A. 2-inches and Smaller: Class 125, bronze body, horizontal swing, regrinding type, Y-pattern, renewable disc. Nibco 413.

B. 2-1/2-inches and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends. Nibco F918.

C. Rubber Flapper Check Valve: Horizontal or vertical upward flow installation. Working pressure to 175 PSI. Ductile iron or cast iron body. Steel reinforced Buna-N rubber flapper epoxy coating on wetted parts. Apco Series 100l, Crispin RF Series.

2.11 LIFT CHECK VALVES

A. 2-inches and Smaller: Bronze body, 125 PSI, spring loaded, Teflon seat. Steam Service, Teflon Disc: Nibco 480Y. Water, Gas or Oil Service, Buna-N Disc: Nibco 480.

B. 2-1/2-inches and Larger: Iron body, 125 PSI, spring loaded, bronze seat and disc. 125 PSI Service: Nibco W910. 250 PSI Service: Nibco W960

2.12 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)

A. Bellows-type, stainless steel casing and bellows, pressure rated, tested and certified in accordance with PDI WH-201. Manufacturers: Amtrol, Inc., J. R. Smith, Wade, Zurn, or approved equivalent.

B. Piston-type, copper, brass or stainless steel with O-ring piston, pressure rated, tested and certified in accordance with PDI WH-201. Manufacturers: PPP, Sioux Chief, or approved equivalent.

2.13 THERMOMETERS

A. 3-inch diameter bi-metal dial thermometer with stainless steel case, white dial, black numbers with 4-inch stainless steel stem and brass separable socket. Provide back or bottom connections as required. 0F to 200F range. Manufacturers: Weiss, Palmer, Ashcroft, Trerice, Marshaltown, Weksler, or approved equivalent.

2.14 PRESSURE GAUGES

A. Single-pointer gauge with 0 to 100 range, 10 PSI intervals and 1 PSI increments intermediate graduations. Aluminum dial with 1 percent accuracy and low bottom connections for wall mounting. Manufacturers: Weiss, Palmer, Marshaltown, Trerice, Ashcroft, Weksler, U.S. Gauge, or approved equivalent.

2.15 SINGLE-STAGE BAG FILTER ASSEMBLY

A. General: Filter assembly to include duplex Type 316 stainless steel pressure rated vessel with 4-inch flanged connections, pressure gauges, isolation valves, and interconnecting pipe manifold.

B. Performance: Rate each filter vessel in the assembly for:
   1. Peak Flow: 120 GPM
   2. Maximum Pressure: 300 PSIG

C. Construction: ASME rate each pressure vessel for 300 PSIG working pressure and constructed from Type 316 stainless steel. Provide the pressure vessels with hydraulic davit type lid openings. Provide flange connections on the interconnecting pipe manifold. Construct the pipe manifold from Schedule 40, Type 316 stainless steel pipe either welded or threaded connections. Provide each filter vessel with an internal coating of Teflon.

D. Bag Filters: Construct bag filters from polypropylene felt material. Seams will be heat welded. Furnish each filter with stainless steel locking ring assembly. Filters will be provided at levels of filtration:
   1. Stormwater Pre-Filter - 20 microns.
   2. Stormwater Final Filter - 5 microns.

2.16 WATER BOOSTER PUMPS

A. Booster Pump Package: UL Listed and have components frame mounted, piped, painted, wired and factory tested. Package includes duplex pumps, manifolds, hydro-pneumatic bladder tank, and control panel. Package will have single point power connection (see schedule on drawings for electrical requirements) and include transformer for lower voltage requirements.

B. Pumps:
   1. Vertical mounted, close coupled, end suctions, cast iron type with bronze fitted construction and mechanical seals or vertical multi-stage with stainless steel fitted construction, and mechanical seals as called out on the plans. Pumps casings includes vent and drain ports at the top and the bottom of the casings.
   2. Rate pumps with a maximum working pressure of 175 PSIG and 225F continuous operating temperature. Manufacturer certifies ratings.
   3. Pumps to run without excessive noise or vibration.

C. Pump motors VFD-rated and meet requirements of NEMA MG1 Sections IV 31.4.4.2 for premium efficiency motors. Motor has TEFC enclosure.

D. Each pump and motor to have nameplate listing manufacturer's name, pump serial number, capacity in GPM and feet of head at design conditions, motor horsepower, voltage, frequency, speed and full load current.

E. Check Valves: Silent center guided type with resilient rubber seats and stainless steel spring. Check valves has cast iron bodies with fusion epoxy coating and bronze discs.

F. Pressure reducing valves have ductile iron globe style with bronze trim and a FDA approved fusion bonded epoxy coating.

G. Valves have minimum operating pressure of 250PSI. Pilot operated valves include a speed control valve and strainer in the pilot piping.

H. Provide isolation valves at inlet and outlet of each pump and union or flange connections. Valves to be butterfly or ball valves.

I. Pump Manifold Header Piping: Schedule 10 welded, 304 stainless steel for cold water and Schedule 10 welded, 316 stainless steel for hot water. Design header pipe size for a maximum of 8 fps velocity. Perform pipe welds by ASME Section IX certified welders and weld piping to ASME/ANSI B31-9 Specifications. Flanged connections to headers.

J. Supply pressure transducers on the suction and discharge manifold headers and factory wired to the control panel.

K. Fit each pump with a thermally activated purge valve to allow water to be purged to remote drain in the event of system over heating.

L. Control booster pump package by a skid mounted and factory wired, UL 508 listed, control in a NEMA 4X enclosure with single point power connections and necessary components to allow for automatic operation of the variable speed pumps. Panel includes the following components:
   1. Variable Frequency Drive for each motor.
   2. Main power disconnect.
   3. Through door circuit breaker disconnect for each VFD.
   4. H-O-A selector switch for each pump.
   5. Control circuit transformer with protected secondary.
   6. Digital programmable logic controller with door mounted LED display with minimum of three lines of text and keypad.
   7. Audio General Alarm - with push to silence button.
   8. Pump operation and status lights:

a. Door mounted status lights include as minimum:
   1) Pump Run
   2) Pump Out of Service
   3) General Alarm

9. Provide a set of dry contacts, wired to terminal strip in the control panel for transmission of general fault alarm to building automation system. General fault includes: pump fault, VFD fault, PLC fault, transducer failure, high system pressure, low suction pressure, overload and network failure. PLC provides data log of system faults. Display these faults in English text on the door mounted supervisory controller (HMI).
10. Micro-processor based supervisory controller (HMI) be panel door mounted unit with graphic type LCD display and sealed membrane keypad. Controller includes PID control, floating point math with square root function and control VFD's through a network interface. In addition to sending run command and speed reference signal to the VFD's through network interface, HMI displays line voltage, output frequency, output current and fault conditions for each VFD. HMI provides an easy to use operator interface to system parameters and display those parameters in plain English and engineering units. Monitoring functions be available to users, but restrict access to parameters by two levels of password protection.
11. Standard Variable Frequency Drive (VFD) features includes over current, earth fault, electronic motor overload protection, over temperature, over voltage, under voltage, phase failure, PID close-loop controller, and automatic energy saving mode, motor synchronization, and user macro storage, auto restart after power failure, electronic motor potentiometer, 16 mixed frequencies and min/max frequency limitation.
12. Control logic includes an energy saving proof of no demand shutdown, NDS, which tests system demand and then shuts off the lead pump if no demand is proven. Lag pump(s) shut off when it operates at its minimum speed for an adjustable elapsed time. Control logic also includes energy saving feature of dynamic set-point adjustment, DSA, which automatically lowers or increases system discharge operating pressure set point as the system demand changes. Controls automatically stage pumps and adjusts pump speed based on discharge pressure control. Rotate lead and lag pumps after each system shutdown. Controls start lag pump on lead pump failure and will shut down system if an over water temperature condition occurs. Controls include pump minimum run time and pump maximum run time adjustable set points.
13. Preassemble the entire system on heavy structural steel frame. Weld the frame in accordance with AWS D1.1 Specifications. Steel frame has zinc oxide primer and machine enamel topcoat.
14. ASME rate hydro-pneumatic bladder tank with ring stand base and replaceable bladder. Tank will ship loose for field installation. Tank provided and installed with union isolation ball valve, pressure gauge, and drain valve.
15. Reference schedule on Drawings for capacity requirements of pumps.
16. Basis-of-Design: FlowTherm Systems by Columbia Hydronics Company.

2.17 WELL PUMPS

A. General: Stainless steel construction, 4-inch, multi-stage well pump. Provide pump designed to operate continuously without damage to the motor and install as recommended by the Manufacturer. Wetted surfaces to be lead free. Construct pump with FDA compliant non-metallic parts where in contact with the water. The pump assembly will be NSF/ANSI 61 listed for use in potable water systems, and UL778 recognized and CSA listed.

B. Motor: Provide UL778 recognized motor constructed for continuous service. The NEMA motor is to be constructed from corrosion resistant stainless steel and furnished with a stainless steel splined, six-sided shaft with Kingsbury type thrust bearings. Motor windings will be hermetically sealed. A control box will be provided for three phased units and will require a magnetic starter with three leg Class 10 overload protection.
   1. Motor Adapter: Provide motor adapter constructed of investment cast, Type 304 stainless steel for strength and accurate alignment of the motor and water end.

C. Pump: Provide pump impellers constructed from Noryl with Lexan diffusers. Bearing material to be urethane and fluted for free passage of abrasives and resistant to sand damage.
   1. Provide enclosed design impeller constructed of Noryl ® for strength, corrosion resistance and abrasive resistance. Due to design and low weight inherent with this size impeller balancing shall not be required. Provide impeller with a hex bore which will allow for easy installation and replacement on the precision stainless steel hex shaft. The impeller stack will float on the shaft assembly providing a pathway for any debris which has entered the pump to exit upon each start up cycle. Designs requiring a fixed impeller/stage stack are not considered equal.

D. Maximum Water Temperature: The pump (water end) can be immersed in 140 degrees F. Standard motor maximum temperature is 86 degrees F, but motors can be derated for hotter water by upsizing the motor HP and installing a flow sleeve.

E. Controls:

F. Basis-of-Design: Goulds Pumps, 7GS Series

2.18 ASME HYDRO-PNEUMATIC BLADDER TANKS

A. Welded steel, constructed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code for working pressure of 125 PSI. Support floor mounted tanks with steel legs or ring base and replaceable bladder to maintain design expansion capacity. Provide pressure gauge and air-charging fitting, and drain fitting.

B. Manufacturers: Mueller, Amtrol, Armstrong, Taco, Bell & Gossett, or approved equivalent.

2.19 ULTRAVIOLET STERILIZERS

A. Manufacturer: Physical layout of system shown on Engineering Drawings and equipment specified in these specifications are based solely upon UVLogic System, as manufactured by Trojan Technologies, Inc. To be acceptable, UV system must operate in an enclosed vessel having “boot” reactor design and use amalgam UV lamps. UV system must be designed to fit within piping footprint described, without modification. Amalgam lamp system is to be furnished with latest components with equipment available at time of shipment.

B. General Requirements
   1. Provide UV system complete with UV reactors, control panels, UV intensity monitoring system, and automatic wiping system, as specified.
   2. Design each system to allow for complete system shut down or by-pass.
   3. Flow through system not to be disrupted while changing of UV lamps is being carried out.
   4. Performance Requirement: Ultraviolet system produces finished water conforming to following requirements: Disinfection of potable water with UVT of 95 percent or greater, to meet WHO dosage recommendations.

C. Quality Assurance:
   1. Prequalification Requirements:
      a. To be acceptable, manufacturer must be able to demonstrate to satisfaction of Engineer successful performance with Amalgam UV lamp systems in similar applications.
      b. Manufacturer must be able to demonstrate at least three permanent installations of this equipment type in similar applications.
   2. Design Criteria:
      a. Provide UV equipment, which disinfects pre-treated water having following characteristics:
         1) Peak Flow: 45 GPM.
         2) Influent water temperature range: 41F to 77F/ 5C to 25C.
         3) Ultraviolet transmittance at 253.7 nm: 95 percent (assumed minimum)
         4) UV dose at end of lamp life: >59.00 mJ/cm2
         5) Standard to be achieved: Disinfection to EPA drinking water standards.
      b. The total head loss across the UV system at peak flow will not exceed 2 PSI / 13.8kpa.

D. Design, Construction and Materials:
   1. General:
      a. Metal components in contact with the feed water: Type 316L stainless steel, which has been passivated and electro-polished.
      b. Material exposed to UV light: Type 316L stainless steel, Type 219 quartz or a suitably UV resistant material.
      c. Design system for complete immersion of UV lamps including electrodes and full length of lamp in water. Lamp electrical connections to be at one end of UV lamp. Major axis of UV lamps to be parallel to flow.
   2. UV Reactor:
      a. Manufacture each UV reactor using stainless steel, which is closed on one end and open on other.
      b. Wetted Materials: Type 316L stainless steel which has been passivated and electro-polished.
      c. Each UV reactor has drain port fixed to its outer wall.
      d. Design each UV reactor to fit into existing pipe work.
      e. Each UV reactor accepts its respective UV lamps and quartz sleeves through only one end of vessel. This end of UV reactor allows for complete reactor entry so internal inspection and/or service can be accomplished.
      f. Service side of UV reactor and UV lamp sleeve seals made using suitable o-ring materials.
      g. UV reactors be able to operate at maximum inlet pressure of 150 PSI and be furnished with factory certified pressure test report detailing minimum hydrostatic pressure test of 225 PSI for at least 20 minutes.
      h. Each UV reactor has its inlet flange fitted to open end of pipe and outlet flange fitted to side wall of vessel so as to ensure minimum hydraulic efficiency of 80 percent.
      i. Factory certified computational fluid dynamic calculations are to be furnished with alternate bids so as to substantiate hydraulic efficiency requirements.
      j. UV reactors possess ability of being mounted horizontally or vertically.
   3. UV Lamps:
      a. Filament: Significantly rugged to withstand shock and vibration.
      b. Lamp bases to be resistant to UV and ozone.
      c. Terminate electrical connections to UV lamp at one end.
      d. UV lamps has lamp base design which prevents arcing between electrical pins.
      e. UV lamps has monochromatic spectral output, with the emissions peaking at 254 nanometers.
      f. MIX mercury contained in lamps with base metal and fix to inside wall of UV lamp quartz.
   4. Lamp End Seal and Lamp Holder:
      a. Seal the open end of UV lamp sleeves to sleeve guide by suitable compression o-ring.
      b. O-ring compression is made by sleeve nut, which require no special tools for installation or removal.
      c. Each UV lamp electrical connection incorporates sealing boot which is held firmly in place by sleeve nut to prevent emission of ultraviolet rays.
   5. UV Lamp Sleeves: Use Type 219 clear fused quartz tubing, closed at one end.
   6. Electronic Power Supplies:
      a. Power pair of UV lamps by one electronic power supply.
      b. Electronic power supply not be frequency dependent.
      c. Each lamp within pair operates on its own circuit within power supply so as to prevent consecutive lamp failures should one lamp fail.
      d. UV lamps are to be operated by an electronic power supply; which automatically adjusts lamp output as function of lamp age so as to maintain required UV dose.

e. Electronic power supplies possess the ability of varying the outputted electrical power to the lamps; thereby providing UV output variability with respect to lamp age and UV dose provision.

7. Electrical:
   a. Power each UV system from remote mountable System Control Center (SCC) by means of waterproof cable interfacing with watertight strain relief.
   b. System Control Center: 304 stainless steel construction.
   c. System Control Center electrical rating be minimum of NEMA 3R.
   d. Maximum total power consumption be no greater than 1.64kW.
   e. Electrical supply to each System Control Center: 208-240 volts, 1 phase, 60 Hz, 62kVa.
   f. Signal wiring interfacing UV system and System Control Center be as shown on Engineering Drawings.
8. Automatic Wiper:
   a. Each UV system incorporates an automatic quartz sleeve cleaning system.
   b. Quartz sleeve cleaning system be mechanically actuated wiping system.
   c. Series of wiper plates be driven over quartz sleeves by an electric motor so as to prevent any debris from adhering to quartz sleeves in system.
   d. Full cleaning cycle consists of wiper plate(s) being driven lengths of quartz jackets, returning again to their place of initiation.
   e. Wiper automatically homes itself at initiation of cleaning cycle or in event of a power failure.
   f. Cleaning Cycles: Configurable with minimum cycle time being every 10 minutes, to maximum of once per day.
9. Control and Instrumentation:
   a. System Control: To be microprocessor based. Operator interface is to be display type only and be located indoors.
   b. Alarm Conditions:
      1) Individual lamp failure: Indicate failed lamps by specific address (i.e. lamp #). Indicate position in reactor via lamp numbered fixed to lamp wiring at service end of UV reactor.
      2) UV Intensity and Low UV Alarm: Intensity to be monitored by silicon carbide diode with UV intensity displayed in µwatts/cm2. Low UV alarm will occur once minimum design UV intensity has been exceeded.
      3) 4-20mA out signal be available for remote monitoring of UV intensity.
      4) Lamp Life Status: At end of UV lamp(s) lifetime (8760 hours) elapsed time meter will flash continually for next 240 hours to alert operator that lamps in reactor require change out.
      5) Remote ON/OFF capabilities are to be provided.
10. Spare Parts: The following spare parts and safety equipment to be supplied:
    a. 4 UV lamps
    b. 2 Quarts sleeves
    c. 6 Sleeve holder seals
    d. 2 Face shields, able to block UV light wavelengths between 200 and 400nm.
    e. 2 Electronic power supplies.
11. Guarantee:
    a. Equipment: Equipment furnished under this section to be free of defects in materials and workmanship, including damages that may be incurred during shipping, storage, and installation for period of 1 year from date of start up or 1-1/2 years from date of shipment.
    b. UV Lamps: UV lamps are to be warranted for minimum of 8000 hours.

2.20 SMOOTHING INLET FITTING

A. Inlet filling constructed from Type 304 stainless steel. The fitting connects to Schedule 40, 8-inch PVC inlet pipe.

B. Basis-of-Design: J.R. Smith RH9530SO-08.

2.21 FRP STORAGE TANKS - BELOW GRADE INSTALLATIONS

A. Loading Conditions - Tank to meet the following design criteria:
   1. Internal Load: Tank to withstand a 5 PSIG air-pressure test with 5:1 safety factor. When tank is designed for on-site testing, individually test tank for leakage prior to installation. Maximum test pressure is 5 PSIG (3 PSIG for a 12-foot diameter tank).
   2. Vacuum Test: To verify structural integrity, design every 10-foot diameter and smaller tank to withstand a vacuum test to 11.5-inches of mercury.
   3. Surface Loads: Tank to withstand surface H-20 axle loads when properly installed according to tank manufacturer's current Installation Manual and Operating Guidelines.
   4. External Hydrostatic Pressure: Provide tank capable of being buried in ground with 7-feet of overburden over the top of the tank, the hole fully flooded and a safety factor of 5:1 against general buckling.
   5. Tank to support accessory equipment, such as internal pump platforms, drop/fill tubes, submersible pumps and ladders, when installed according to tank manufacturer's current Installation Manual and Operating Guidelines.

B. Product Storage:
   1. Provide tank capable of storing water products with specific gravity up to 1.1.
   2. Provide tank vented to atmospheric pressure.
   3. Provide tank capable of storing products identified in the manufacturer's current standard limited warranty.

C. Materials:
   1. Provide tank manufactured with 100 percent resin and glass-fiber reinforcement. No sand fillers.
   2. The laminate materials used in the internal coating system of a potable water tank to conform to the requirements of NSF Standard 61.

D. Tank Dimensions:
   1. Tank to have nominal capacity of 25,000-gallons.
      a. Tank to have nominal outside diameter of 10-feet.

E. Accessories:
   1. Anchor Straps: FRP anchor straps as supplied by tank manufacturer. Provide number and location of straps specified in current literature by tank manufacturer.
   2. Manways: Flanged and 22-inch nominal diameter, complete with gasket, bolting hardware and cover. (30-inch and 36-inch nominal diameter manways are also available on certain larger tanks.) Manway Extensions: FRP.
   3. Drop/Fill Tubes: FRP. Terminate a minimum of 4-inches from the bottom of the tank.
   4. Ladders: Provide removable aluminum ladders for each tank.
   5. Tank Fittings - Threaded: Construct threaded fittings of stainless steel or FRP. Provide threaded fittings as half-couplings and 2-inch, 4-inch, or 6-inch in diameter. Provide reducers as required.
   6. Tank Fittings - Flanged: Provide flat-faced and flanged FRP nozzles that conform to ANSI B16.5, 150# bolting pattern.
      a. Internal Support Platforms: Provide platforms in FRP or Type 316 stainless steel.

F. Basis-of-Design: Xerxes Corporation, Single-Wall FRP tank for below grade installation.

2.22 PRESSURE SWITCHES

A. General: Standard pressure switch for control of electrically driven water pumps. The switch is diaphragm actuated and includes two 1/4-inch poles. 18 NPSF internal thread with 1/4-inch opening. 220 PSIG maximum pressure rating with low pressure cut-off at 40 PSIG.

B. Basis-of-Design: Square D, Model FSG2J24M4CP.

2.23 FLOAT SWITCHES

A. General: Mercury activated, wide-angle switch designed to control pumps up to 1 hp at 120 VAC and 2 hp at 230 VAC. The switch is not sensitive to rotation or turbulence. Mercury-to-mercury contacts, hermetically sealed in a steel capsule. The power cable is water resistant (CPE), flexible, 14 gauge, two conductor. The float housing is constructed from high impact, corrosion resistant, PVC housing for use in sewage and non-potable water up to 140 degrees F. Unit includes standard mounting clamp.

B. Switch assembly is CSA certified, and UL recognized for use in non-potable water and sewage. This switch must be used with pumps that provide integral thermal overload protection. Switch is suitable for use with intrinsically safe circuits. Switch is furnished with a three-year warranty.

C. Basis-of-Design: SJE Rhombus, Model “Super Single” Pump Switch.

2.24 AERATION SYSTEM FOR CISTERNS

A. General: Electric Aerator for above grade installation. Unit will have sufficient capacity to produce minimum 3.5 SCFM compressor air at a minimum 25 PSIG. Unit includes a 1/3 hp motor and a 110 SCFM circulating fan.

B. Accessories: The assembly is furnished with 100-feet of ½-inch polytubing, an air stone, and a foot valve.

C. Freeze Control Unit: Unit is provided as an optional feature. The unit injects alcohol into the air stream to prevent freezing in the air line.

D. Basis-of-Design: OWS, Model EAU0048 aerator with Model FCU0039 freeze control unit.

2.25 PRIMING FILL VALVE

A. All brass construction with EPDM or Buna-N elastomeric seals. Low pressure reducing valves with a low inlet pressure check valve and removable strainer. Provide with an adjustable range between 10- to 25-psig, and a factory setting of 12-psig.

B. Basis-of-Design: Bell & Gossett, Model B38TU

2.26 RAINWATER DAY TANK (RST-1)

A. General: The tank structure shall consist of corrugated galvanized steel wall sheets, an interior joist roof system covered with flat galvanized steel roof panels, 24-inch round access opening and cover removable side access panel shall be provided for use during tank construction and for emergency access.

B. Nominal tank dimensions shall be 6'-0" diameter, 7'-3" eave height, and 7'-7" overall height.

C. The water storage tank shall be designed to store water with a density of 62.4 PCF in a seismic zone 2B with a wind speed of 90 MPH, UBC Exposure C.

D. All steel panel material shall be galvanized to meet the G-115 galvanized standard.

E. The water tank shall be constructed on a concrete foundation as designed and installed by others.

F. Assembly Hardware:
   1. Bolts shall be heat treated to grade SAE 8.2 and electro-galvanized with JS-500 clear coating.
   2. Roof bolts shall have factory installed, steel-backed vinyl washers.
   3. Wall bolts shall have slotted button heads for insertion from inside the tank toward outside.

G. Tank Lining: Water containment system shall consist of liner hanger brackets, a geotextile pre-liner installed on the foundation and the interior of the walls and a 25-mil, reinforced polyethylene factory welded seam, flexible membrane main liner.

H. Basis-of-Design: The water storage tank shall be a CorGal Model 0602-WT-FR or equal with flat steel roof having a nominal capacity of 1,300 US gallons.

2.27 DISSOLVED OXYGEN SENSOR AND MONITOR (DOS-1)

A. Monitor: NEMA 4X fiberglass-reinforced polyester enclosure with LED digital display. Monitor can be calibrated in the field. The monitor will provide a 4-20 mA output, and have two independent relays capable of controlling external devices. The alarm relay will have both high and low setpoints with a fixed deadband. A self-diagnostic program will indicate system failures or faults. Accuracy to be within +/-0.1 ppm. Automatic temperature compensation included.

B. Sensor: Hermetically sealed cartridge with 8-meter long cable and integral failure alarm.

C. Basis-of-Design: Omega DOCN601 monitor with DOE-601-SC sensor. Provide with DOE-600-SMK submersion mounting kit.

PART 3 - EXECUTION

3.01 CHLORINATION

A. General: Upon completion of tests and necessary replacements, thoroughly flush and disinfect water piping.

B. Method: After thoroughly flushing system with water to remove sediment, fill system with solution containing 50 parts per million of chlorine for not less than 24 hours or 200 parts per million of chlorine for not less than 3 hours. After retention, drain, reflush and return system to service.

C. Certification: Provide copy of domestic water chlorination certificate in each operations and maintenance manual.

3.02 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

D. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.

E. Establish elevations of buried piping outside building to ensure not less than 2-feet of cover minimum code required.

F. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.

G. Provide support for utility meters in accordance with requirements of utility companies.

H. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Reference Architectural Sections.

3.04 POLYPROPYLENE PIPING APPLICATIONS

A. Install listed pipe materials and joining methods in the following applications:
   1. Non-potable water pressurized systems used for rainwater catchment: Polypropylene (PP-R) piping in SDR 7.4 for sizes 1/2-inch and 3/4-inch, and SDR 11 for sizes 1-inch through 10-inch.

B. Install fittings and joints using socket-fusion, elecrofusion, or butt-fusion as applicable for the fitting or joint type. Fusion-weld joints are made in accordance with the pipe and fitting manufacturer's specifications and product standards.

C. Fusion-weld tooling, welding machines, and electrofusion devices are specified by the pipe and fittings manufacturer.

D. Prior to joining, the pipe and fittings are prepared in accordance with F 2389 and the manufacturer's specifications.

E. Joint preparation, setting and alignment, fusion process, cooling times and working pressure is in accordance with the pipe and fitting manufacturer's specifications.

F. When installed in systems with pumps in excess of 7.5 HP, piping is protected from excessive heat generated by operating the pump at shut-off conditions. Where the possibility exists that the pump will operate with no flow, the protection method is a temperature relief valve or comparable level of protection, set to a maximum temperature of 185 degrees F.

G. If heat tracing is specified for the piping, it should be installed on the pipe exterior, and it must be suitable for use with plastic piping and self-regulating to ensure the surface temperature of the pipe and fittings will not exceed 70°degrees C (158°degrees F).

H. Inspecting and Cleaning:
   1. The pipes should be flushed with cold water after finishing the installation. Inspect and test piping systems following procedures of authorities having jurisdiction and as specified by the piping system manufacturer.

3.05 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

A. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.

B. Manufacturers: Hilti, Proset, or approved equivalent.

3.06 PROTECTION

A. Protect fixtures and equipment from damage. Replace damaged items with new.

B. Keep pipe openings closed by means of plugs or caps to prevent entrance of foreign matter. Protect piping, ductwork, fixtures, equipment and apparatus against dirty water, chemical or plumbing damage both before and after installation. Restore to its original condition or replace fixtures, equipment or apparatus damaged prior to final acceptance of work.

C. Protect bright finished shafts, bearing housings and similar items, until in service; no rust will be permitted.

D. Cover equipment and materials stored on the job site or otherwise suitably protect at the direction and the satisfaction of Architect. If coverings become torn, replace until the equipment is connected and operating.

3.07 FIXTURES INSTALLATION

A. General:
   1. Install fixtures, equipment and devices of types indicated where shown and at indicated heights; in accordance with manufacturer's written instructions, roughing-in drawings, and with recognized industry practices. Ensure that installation complies with requirements and serve intended purposes.
   2. Verification of Conditions: Examine roughing-in work of piping systems to verify actual locations of piping connections prior to installing. Examine floors and substrates, and conditions under which work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of systems.

B. Extra Stock: Furnish special wrenches and other devices necessary for servicing devices and equipments to Owner.

C. Field Quality Control:
   1. Upon completion of installation of and after units are water pressurized, test fixtures, equipment and devices to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
   2. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect. Remove cracked or dented units and replace with new units.

D. Adjusting and Cleaning: Piping: Clean piping exterior surfaces. Comply with Section 22 07 00, Plumbing Insulation, as applicable. Flush out water filled or drainage piping systems with clean water.

3.08 WATER BOOSTER PUMPS

A. Installation:
   1. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.
   2. Field piping includes connections to suction and discharge headers, drain piping and piping to hydro-pneumatic pressure tank, when not skid mounted, with union ball valve, pressure gauge, and drain.
   3. Field electrical connections include main power to the control panel and control wiring to remote pressure transducer if required.

B. Cleaning: Flush and clean piping prior to testing.

C. Testing:
   1. Manufacturer pressure tests system prior to shipment. Test piping with water to pressure of 125 PSI for 1 hour. No decrease in pressure allowed Inspect joints in system under test.
   2. Defective work or material to be replaced or repaired as necessary and inspection and test repeated. Make repairs with new materials. Test reports included in owner's manual.
   3. Manufacturer tests control panel including operating logic, safeties and wiring prior to shipment.
   4. Provide pressure test and control panel test reports signed by manufacturer and included with equipment O&Ms.
   5. Manufacturer's representative provides system check and start-up service for system. Warranty system (including parts and labor) for a period of 12 months from date of start-up or 18 months after shipment, which ever comes first.

3.09 EQUIPMENT CONNECTIONS

A. Piping Runouts to Fixtures: Provide piping runouts to fixtures of sizes indicated, but in no case smaller than required by code.

B. Mechanical Equipment Connections: Connect piping system to equipment as indicated, and comply with equipment manufacturer's instructions. Provide shutoff valve and union for each connection; provide drain valve on drain connection.

3.10 EXCAVATION AND BACKFILL

A. General: Perform necessary excavation and backfill required for installation of plumbing work. Repair piping or other work at no expense to Owner. Recommendations from the Geotech Report, if provided, to take precedence over the requirements of this section.

B. Water: Keep excavations free of standing water. Fill back, compact and re-excavate excavations damaged or softened by water or frost to original level with sand, crushed rock or other approved material at no expense to Owner.

C. Tests: During progress of work for compacted fill, Owner reserves right to request compaction tests made under direction of testing laboratory.

D. Trench Excavation: Excavate trenches to necessary depth and width, removing rocks, unstable soil (muck, peat), roots and stumps. Excavation material is classified as "base fill" and "native." Base fill excavation material consisting of placed crushed rock may be used as backfill above "Pipe Zone." Remove and dispose off site native excavation material. Provide adequate width of trench for proper installation of piping or conduit.

E. Support Foundations:
   1. Foundations: Excavate trenches located in unstable ground areas below elevation required for installation of piping to depth which is determined by Architect as appropriate for conditions encountered. Place and compact approved foundation material in excavation up to "Bedding Zone." Dewatering, placement, compaction and disposal of

excavated materials to conform to requirements contained in other sections of Specifications or Drawings.

2. Over-Excavations: Where trench excavation exceeds required depths, provide, place and compact suitable bedding material for proper grade or elevation at no additional cost to Owner.
3. Foundation Material: Where native material has been removed, place and compact necessary foundation material to form base for replacement of required thickness of bedding material.

	Class A		Class B	
Material Passing	**Min.**	**Max.**	**Min.**	**Max.**
3/4-inch Square Opening	27	47	0	1

4. Bedding Material: Full bed piping on sand, pea gravel, or 3/4-inch minus crushed rock. Place minimum 4-inch deep layer of sand, pea gravel, or crushed rock on leveled trench bottom for this purpose. Remove bedding to necessary depth for piping bells and couplings to maintain contact of pipe on bedding for its entire length. Provide additional bedding in excessively wet, unstable, or solid rock trench bottom conditions as required to provide firm foundation.

F. Backfilling:
   1. Following installation and successful completion of required tests, backfill piping in lifts.
      a. In "Pipe Zone" place backfill material and compact in lifts not to exceed 6-inches in depth to height of 12-inches above top of pipe. Place backfill material to obtain contact with entire periphery of pipe, without disturbing or displacing pipe.
      b. Place and compact backfill above "Pipe Zone" in layers not to exceed 12-inches in depth.
   2. Backfill Material:
      a. Backfill Material in "Pipe Zone": 3/4-inch minus crushed rock, sand or pea gravel.
      b. Crushed rock, fill sand or other backfill material approved elsewhere in Specifications may be used above "Pipe Zone."

G. Compaction of Trench Backfill:
   1. Where compaction of trench backfill material is required, use one of following methods or combination thereof:
      a. Mechanical tamper,
      b. Vibratory compacter, or
      c. Other approved methods appropriate to conditions encountered.
   2. Architect to have right to change methods and limits to better accommodate field conditions. Provide compaction sufficient to attain 95 percent of maximum density at optimum moisture content unless noted otherwise on Drawings or elsewhere in Specifications. Water "puddling" or "washing" is prohibited.

3.11 PIPE INSTALLATION

A. Seismic Restraint: Brace plumbing piping and plumbing equipment against lateral movement as detailed in document "Seismic Restraint Manual Guidelines for Mechanical Systems" as published by SMACNA.

B. Rough-in Piping: Provide temporary caps or plugs at piping shown on Drawings to be roughed-in for future connections by others.

3.12 FRP STORAGE TANKS - INSTALLATION AND TESTING

A. Testing: Test tank according to the Xerxes Installation Manual and Operating Guidelines in effect at time of installation.

B. Installation: Install tank according to the Xerxes Installation Manual and Operating Guidelines in effect at time of installation. Contractor to receive training by the tank manufacturer, the State or other approved agency.

3.13 TESTING

A. General:
   1. Provide temporary equipment for testing, including pumps, compressors, tanks, and gauges, as required. Test piping systems before insulation (if any) is installed and remove or disengage control devices before testing. Where necessary, test sections of each piping system independently, but do not use piping valves to isolate sections where test pressures exceed local valve operating pressure rating. Fill each section with water, compressed air, or nitrogen and pressurize for the indicated pressure and time.
   2. Notify Architect and local Plumbing Inspector 2 days before tests.
   3. Water Piping: Eliminate air from system. Fill and test at 125 PSIG or minimum 1-1/2 times static pressure at connection to serving utility main for period of two hours with no loss in pressure.
   4. Send test results to Architect for review and approval.

B. Testing of Pressurized Systems:
   1. Test each pressurized piping system at 150 percent of operating pressure indicated, but not less than 125 PSIG test pressure.
   2. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 2 percent of test pressure.

3.14 ADJUSTING AND CLEANING

A. Piping: Clean piping exterior surfaces. Comply with Section 22 07 00, Plumbing Insulation, as applicable. Flush out water-filled or drainage piping systems with clean water.

3.15 ACCESS PANELS

A. Confirm additional access doors/panel requirements in Division 08, Openings and Section 22 00 00 Basic Plumbing Requirements.

B. Install ceiling or wall access panels to provide access to concealed valves, motors, shock arrestors, and other plumbing items needing service. Provide access panels at locations required or as specified. Coordinate locations/sizes of access panels with Architect prior to work.

3.16 ELECTRICAL

A. Provide complete design, supply and installation of electrical service to each piece of equipment and device connection, including raceway, conductors and boxes as described in Division 26, and as required by NEC.

B. Use standby-power backed power to connections.

3.17 SIGNAGE

A. All fixtures connected to the non-potable storm water reuse system are to be provided with a wall sign that says "Caution: Non Potable Water, Do Not Drink."

END OF SECTION

SECTION 22 3000
PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Emergency Stop Pushbutton Switch
   2. Commercial High Efficiency Storage Type Gas Water Heaters
   3. Domestic Expansion Tanks ASME
   4. Elevator Simplex Sump Pump System
   5. Garbage Disposal
   6. Grease Interceptors - Prefabricated HDPE

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Seismic anchor details and calculations signed and stamped by licensed Oregon structural engineer with equipment data.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. NSF 61, Annex G compliant.
   2. ISO 9001 Certified.
   3. IAPMO Low Lead Certification

C. Products approved for installation by state authorizing agency, no exceptions.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. As specifically listed in Articles below or approved equivalent.

B. Submersible Pumps:
   1. Oil Filled:
      a. Grundfos
      b. Goulds
      c. Hydromatic
      d. Liberty
      e. Zoeller
      f. Or approved equivalent.
   2. Air Filled:
      a. Goulds
      b. Weil
      c. Or approved equivalent.

2.02 GENERAL

A. Reference drawings for capacities and specific model numbers.

2.03 EMERGENCY STOP PUSHBUTTON SWITCH

A. Provide 40mm diameter turn-reset red pushbutton operator with contact blocks to disconnect power to the boiler burner controls and gas service. Square D Class 9001 Family XB5.

B. Manufacturers: Group Schneider/Square D Class 9001 XB5 Family, Eaton, Siemens, General Electric, or approved equivalent.

2.04 COMMERCIAL HIGH EFFICIENCY STORAGE TYPE GAS WATER HEATERS

A. System: Domestic Hot Water.

B. Provide 2 gas fired storage high efficiency (98 percent) water heaters with capacities as indicated on Contract Documents. System to deliver minimum 120 degrees F hot water to tenants.

C. Water Heaters in accordance with certified UL volume III tests and ASHRAE 90.1-2010. Maximum supply gas pressure to heater 13.8 inches WC (0.5 PSI).

D. Water Heaters factory provided with an CSA (AGA) electronic intermittent gas ignition, gas pressure regulator and pilot filter, coated steel burners, draft diverter and flue damper; 120 volt, 60 Hz, single phase electrical connection.

E. Water Heaters factory provided with 2 3/4-inches by 3 3/4-inches hand hole cleanout listed by Underwriters Laboratories. Controls include, upper and lower thermostats, combination temperature and pressure gauge, low water, CSA (AGA) and ASME rated temperature and pressure relief valve, and draft regulator. Control compartment door be hinged for easy access. Heater(s) be equipped with multiple anodes for cathodic protection.

F. Water Heaters be insulated with vermin-proof glass fiber insulation, R 16 Value minimum. Outer jacket to have a baked enamel finish over a bonderized undercoating.

G. Internal surfaces of water heaters exposed to water be glass-lined with alkaline borosilicate, nickelous oxide composition that has been fused to steel by firing at temperature range of 1400 degrees F to 1600 degrees F.

H. Coordinate exact location of units and electrical characteristics with Division 26, Electrical work.

I. Provide seismic anchor calculations for this equipment, stamped and signed by Licensed Oregon State Structural Engineer.

J. Warranty: Three year unconditional tank replacement, one year on parts and devices.

K. Manufacturers: Lochinvar.

2.05 DOMESTIC EXPANSION TANKS ASME

A. System: Domestic water.

B. Welded steel, constructed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code for working pressure of 125 PSI. Support floor mounted tanks with steel legs or base. Provide single flexible diaphragm securely sealed into tank to separate air charge from system water, to maintain design expansion capacity. Provide pressure gauge and air-charging fitting, and drain fitting. Diaphragm: Removable and replaceable in line.

C. Manufacturers: Bell and Gossett Series PT, American Wheatly, Amtrol, Armstrong, Watts, or Hansen.

2.06 DOMESTIC CIRCULATION PUMP

A. Pump shall be of the in-line wet rotor design. Oil lubricated pumps and shaft coupled pumps shall not be accepted.

B. The pump shall be a standard product of a single pump manufacturer. The pump, motor, and variable speed drive shall be an integral product designed and built by the same manufacturer.

C. The enclosure shall be marked “Enclosure Type 2.”

D. The pump shall be certified and listed by a Nationally Recognized Test Laboratory (NRTL) for U.S. and Canada to comply with:
   1. UL778
   2. UL 60730-1A
   3. CAN/CSA No. 108

E. E. The pump shall be labeled on the nameplate as having an Energy Efficiency Index (EEI) of no greater than 0.20.

F. Ratings
   1. Maximum Pressure: 175 PSIG
   2. Minimum Media Temperature: 14 °F
   3. Maximum Media Temperature 230 °F
   4. Maximum Continuous Media Temperature: 203 °F
   5. Maximum Sound Pressure Level: 43dB(A)
   6. Voltage: [1x115V +/-10%][1x208-230V +/-10%]
   7. Maximum Energy Efficiency Index: 0.20

G. Pump Construction
   1. Pump housing: Cast Iron: EN-JGL-250 with Cataphorese surface treatment Stainless Steel: 3 04 Stainless Composite
   2. Impellers: PES 30% GF
   3. Rotor Can: PPS - PPS reinforced with Carbon Fiber(Fortran MT9141L GF40)
   4. Rotor Cladding: 316 Stainless Steel
   5. Stator Housing: Aluminum
   6. Shaft: 316L Stainless Steel
   7. Thrust Bearing: Axial: Carbon Graphite, Radial: Ceramic Alumina Hilox 961
   8. O-Rings: EPDM
   9. Bearing Plate: 304 Stainless Steel
   10. Neck Ring: 304 Stainless Steel
   11. Control Box: Polycarbonate

H. Motor
   1. Motor shall be 4-pole permanent-magnet (PM motor) and tested with the pump as one unit by the same manufacturer. Conventional asynchronous squirrel-cage motors shall not be acceptable.
   2. Each motor shall be of the integrated Variable Speed Drive design consisting of a motor and a Variable Frequency Drive (VFD) built and tested as one unit by the same manufacturer.
   3. The stator housing shall be made of pressure die cast aluminum.
   4. The motor shall be cooled by the pumped fluid
   5. The power electronics shall be cooled to the ambient air.
   6. The Motor shall be self-ventilating.
   7. Minimum insulation class for the motor shall be Class F.
   8. The integrated VFD control shall utilize an energy optimization algorithm to minimize energy consumption by reducing the factory-set setpoint and adjust to system characteristics. This shall be accomplished without the need of any external sensors or input.

I. Operating Modes
   1. The pump shall have the following control mode and operating modes:
      a. AUTOADAPT - During operation, the pump automatically reduces the factory-set setpoint and adjusts it to the actual system characteristic. Manual setting of the setpoint is not possible.
      b. FLOWLIMIT - It shall be possible for the user to select a maximum flow that the pump shall not exceed in order to eliminate the need for additional throttling valves. The pump shall operate per selected control mode but will limit speed to not exceed the user specified flow limit

c. FLOWADAPT - The pump shall operate in the AUTOADAPT control mode with FLOWLIMIT enabled.
d. Proportional Pressure - The head delivered shall be reduced from a manual setpoint linearly in accordance with decrease in flow demand in the system
e. Constant Pressure - A manual set, constant head is maintained, irrespective of flow up to the maximum speed of the pump.
f. Constant Curve - The pump runs as an uncontrolled pump by the means of a set of pump curves. The pump curve adjustable between maximum and minimum from the control panel or through a wireless remote control.
g. Constant Temperature - the pump shall adjust speed to maintain a constant media temperature in the flow pipe in which the pump is installed.
h. Constant Differential Temperature - the pump shall adjust speed to maintain a constant temperature drop between the flow pipe in which the pump is installed and a user installed temperature sensor.
i. Alternating Operation - Two single head pumps or two heads of a dual head pump shall communicate wirelessly to one another. In alternating operation, only one pump shall operating at a time. The operation shall alternate based on time or energy to ensure even run time of both pumps. If a pump stops due to fault the other pump shall take over automatically.
j. Back-Up Operation - Two single head pumps or two heads of a dual head pump shall communicate wirelessly to one another. In Back-Up operation one pump shall operate continuously. If the duty pumps stops due to fault the back-up pump shall take over automatically.
k. Cascade Operation - Two single head pumps or two heads of a dual head pump shall communicate wirelessly to one another. Two pumps shall operate together in constant pressure control. The pump controller shall determine when to operate a single pump or both pumps to meet demands. While both pumps operate they shall run at the same speed.

J. Interface and Communication
1. The pump shall have an integrated operator interface consisting of:
a. Minimum 2.4-inch (measured diagonally) color TFT display
1) 7 push buttons for navigation of menu
2) Push Buttons must be able to operate at minimum 25,000 times
3) Push Buttons must be isolated from the main supply by reinforced insulation according to UL60730
4) LEDs to signal pump status for quick indication
2. The pump shall have a sensor integrated directly into the pump housing with 4 lines consisting of Ground, Supply, and two signals for Differential Pressure and Media Temperature.
a. Sensor Supply shall be 4.8V DC +/- 2% at 20mA referenced to Ground. The supply must be able to withstand a permanent short circuit.
1) The electrical values for the signal shall be 4.8V DC +/-2% referenced to ground.
3. The pump module shall have one analog input configurable for either 4-20mA or 0-10VDC input signal configurable for external Temperature or Pressure sensor, or Setpoint influence. Sensor input shall have three wires for Ground, Supply, and Signal. The Supply for external analog input shall be 24V DC +/-10% at 22mA reference to Ground. The supply must be able to withstand a permanent short circuit. Connection can be made to a screw terminal capable of wire sizes up to AWG16.
4. The pump shall have 3 Digital Inputs galvanically isolated from the main supply by a reinforced insulation according to UL60730.
a. Start/Stop -Used to start or start the pump. The pump shall be enabled when connected to common ground by an external potential free short circuit. An open circuit to this input shall disable the pump. Connection can be made to a screw terminal capable of wire sizes up to AWG16.

1) Minimum - used to force the pump to run at minimum load (curve). When connected to common ground by an external potential free short circuit the pump must run at minimum load. Connection can be made to a screw terminal capable of wire sizes up to AWG16.
2) Maximum - used to force the pump to run at maximum load (curve). When connected to common ground by an external potential free short circuit the pump must run at maximum load. Connection can be made to a screw terminal capable of wire sizes up to AWG16.

5. The pump module shall have two Output Relays. Each relay shall be configurable for Alarm, Reading, or Operating indication. Each relay must have three screw terminals see above. Output relays contacts shall be rated for maximum 250VAC at 2A and minimum 5VDC at 20mA. Each must have galvanic isolation from the internal supply by reinforced insulation according to UL60730.
6. Shall be capable of accepting an optional add-on module for integration into Building Management Systems:
   a. LonWorks
      1) BACnet
      2) Modbus
      3) Profibus
7. The pump module shall have wireless connectivity for two pumps to communicate with one another or for the pump to communicate to a mobile device with additional hardware.
   a. Communication range shall at minimum within 30ft of the pump without walls or barriers.
      1) Two identical pumps shall be capable of wireless communication with one another to operate as a two pump system in:
         (a) Duty/Standby
            (1) Alternating Mode, pumps alternate operation every 24 hours
            (2) Cascade operation with both pumps running simultaneously in constant differential pressure mode.

2.07 ELEVATOR SIMPLEX SUMP PUMP SYSTEM

A. System: Sanitary Sewer.

B. Entire unit is to be delivered complete with operating controls and require only plumbing and electrical service connections.

C. Provide submersible sump pump with 2-inch I.P.S. discharge, bronze fitted construction with submersible sealed motor, stainless steel shaft, bronze impeller, mechanical seal, waterproof 20 ft. power cord and fully submersible float switch for mounting on pump discharge pipe.

D. Provide check valve and shut-off valve on discharge side of pump.

E. Provide bar grated 24-__ inches x 24-__ inches steel basin cover for elevator pit rated to allow 50-GPM gravity flow..

F. Manufacturer: Bell and Gossett Model SE 85 and Model S -1BT128 pump switch.

G. Acceptable manufacturers: Weil, Gould's, Hydromatic, Liberty, or Zoeller.

2.08 GARBAGE DISPOSAL

A. Residential Duty:
   1. General: Complete food waste disposal to include a stainless steel sink flange adapter assembly to match fixture. Dishwasher connection. Stainless steel or galvanized grind chamber, shredder ring, and two 360 degree swivel impellers/lugs. Continuous feed.
   2. Single phase, permanently lubricated motor with manual reset, corrosion protection shield, and sound absorbing upper shell. UL listed.
   3. Warranty: 2 year parts and in-home service.

B. Manufacturers:
   1. In-Sink-Erator
   2. Salvajor

3. Hobart
4. Waste King
5. Or approved equivalent.

2.09 GREASE INTERCEPTORS - PREFABRICATED HDPE

A. Seamless high density polyethylene with built-in flow control constructed and approved for interior or exterior installation.

B. The tank certified by NSF and listed by IAPMO to ASME grease interceptor standard A112.14.3 and rated for on-the-floor or buried applications.

C. Factory installed built-in flow control. Maximum operating temperature 190 degrees F continuous. Integral air relief/anti-siphon.

D. See Drawings for capacities, loading, and similar requirements.

E. Manufacturers: Schier Interceptor as manufactured by Schier Products.

PART 3 - EXECUTION

3.01 GENERAL

A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

C. Orients so controls and devices needing service and maintenance have adequate access.

D. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.

E. Connect water piping to units with shutoff valves and unions as indicated.

F. Equipment Rigging: Heavy duty rigging eye bolts for Crosby Group swivel hoist rings installed over pump access covers for removal or maintenance.

G. Garbage Disposal:
   1. General: Install complete, food waste disposal system including water, waste connections, electrical connection including associated control devices.
   2. Set devices and adjust any support or mounting assemblies per manufacturers recommendations.
   3. Water supplies, as applicable are to be provided with shut-off valves, solenoid valves, backflow preventers and water hammer arrestors.
   4. Coordinate power requirements and connection methods with Division 26.

3.02 BOILER/WATER HEATER/ GAS SHUTDOWN

A. Remote switch: Install shutdown switch. Install pushbutton under clear, impact-resistant flip lid. Provide red phenol label "Emergency Shutdown" locate label above pushbutton. Pushbutton to be mounted by latch side of each boiler/mechanical room door within interior of the room, unless otherwise directed by AHJ. Provide electrical wiring and raceway as necessary for installation. Provide additional relays and wiring to cut power to gas solenoid valves in the room not integral to boilers. Reference drawings for gas solenoid valve locations.

3.03 EQUIPMENT START-UP

A. Start-up, test, and adjust equipment in accordance with manufacturer's start-up instructions. Check and calibrate controls.

B. Start-up performed by authorized manufacturer's representative or agent. Provide credentials of start-up personnel to Architect and Owner's Representative for approval.

C. Remove and replace filters when start-up testing is executed.

D. Manufacturer adjusts operating parameters of equipment to compensate to elevation of 500-feet above sea level.

E. Architect, Commissioning Agent, and Owner's Representative will be notified 10 days prior to start-up and will be present at start-ups.

F. Provide written report from manufacturer's representative on results of start-up within 48 hours.

G. Technical Training of maintenance staff includes four hours minimum per each piece of equipment.

H. Seismic Verification:
   1. Contractor will retain structural engineer who will submit stamped and signed anchoring and restraint details on plumbing equipment with submittal data in accordance with Division 22, Plumbing requirements.
   2. Contractor's Structural Engineer will test and verify in writing that seismic restraints have been installed in accordance with their details.

END OF SECTION

SECTION 22 4000
PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. General Plumbing Fixtures:
      a. China Fixtures, White Only
      b. Faucet Fittings
      c. Fiberglass Fixtures, White Only
      d. Group Wash Fountain
      e. Molded Resin or Stone Fixtures
      f. Stainless Steel Fixtures
      g. Thermostatic Mixing Valves
      h. Wash Fountains
   2. Carriers
   3. Downspout Boot/Nozzle/Cover
   4. Drinking Fountains
   5. Emergency Showers/Eyewash
   6. Fixture Trim
   7. Floor Drains
   8. Floor Sinks
   9. Flushometers - Water Closet/Urinal
   10. Hose Bibbs
   11. Kitchen Equipment
   12. Roof/Overflow Drains
   13. Water Closet Seats

1.02 RELATED SECTIONS

A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Comply with lead free (less than or equal to 0.25 percent) products in drinking water systems.
   2. NSF 61, Annex G, Drinking Water System Components, Compliant.
   3. ISO 9001, Quality Management Standard Certified.
   4. IAPMO Low Lead Certification
   5. Provide fixtures, faucets and accessories to meet barrier free requirements of the governing code with respect to plumbing fixtures provided for the physically handicapped.
   6. Items approved for use by State of Oregon.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. "Or approved equivalent" as defined in 22 00 00, General Plumbing Requirements. Substitution process requirements apply to approved equivalent products.

B. General Plumbing Fixtures: See Schedule on Drawings for type.
   1. China Fixtures - White Only:
      a. American Standard
      b. Briggs
      c. Crane
      d. Eljer
      e. Kohler
      f. Universal-Rundle
      g. Zurn
      h. Or approved equivalent.
   2. Faucet Fittings:
      a. Private:
         1) Chicago
         2) Delta Commercial
         3) Moen
         4) Speakman
         5) Symmons
         6) T&S Brass
         7) Or approved equivalent.
      b. Public:
         1) American Standard
         2) Chicago
         3) Delta Commercial
         4) Moen Commercial
         5) Sloan
         6) Symmons
         7) T & S Brass
         8) Zurn
         9) Or approved equivalent.
   3. Fiberglass Fixtures - White Only:
      a. Aqua-Glass
      b. Briggs
      c. Crane
      d. Fiber-Fab
      e. Hytec
      f. Mustee
      g. Universal-Rundle
      h. Or approved equivalent.
   4. Group Wash Fountain:
      a. Acorn
      b. Bradley
      c. Metcraft
      d. Or approved equivalent.
   5. Molded Resin or Stone Fixtures:
      a. Fiat
      b. Mustee
      c. Stern Williams
      d. Or approved equivalent.
   6. Stainless Steel Fixtures:

a. Elkay
b. Haws
c. Just
d. Or approved equivalent.

7. Thermostatic Mixing Valves:
   a. Bradley
   b. Powers
   c. Symmons
   d. Or approved equivalent.
8. Wash Fountains:
   a. Acorn
   b. Bradley
   c. Or approved equivalent.

C. Carriers:
1. JR Smith
2. Zurn
3. Or approved equivalent.

D. Downspout Boot/Nozzle/Cover:
1. JR Smith
2. Mifab
3. Sioux Chief
4. Zurn
5. Or approved equivalent.

E. Drinking Fountain:
1. Elkay
2. Halsey-Taylor
3. Haws
4. Oasis
5. Sunroc
6. Or approved equivalent.

F. Emergency Showers/Eyewash:
1. Bradley
2. Encon
3. Guardian
4. Haws
5. Speakman
6. Or approved equivalent.

G. Fixture Trim:
1. McGuire
2. Or approved equivalent.

H. Floor Drains:
1. Mifab
2. Sioux Chief
3. Smith
4. Wade
5. Watts
6. Zurn

I. Floor Sinks:
1. Commercial Enameling Mifab
2. Sioux Chief
3. Smith
4. Wade

5. Watts
6. Zurn
7. Or approved equivalent.

J. Flushometers - Water Closet/Urinal:
1. Delaney
2. Sloan
3. Zurn
4. Or approved equivalent.

K. Hose Bibbs:
1. Chicago
2. JR Smith
3. Mifab
4. Wade
5. Woodford
6. Zurn
7. Or approved equivalent.

L. Kitchen Equipment:
1. No products specified. See Part 3 "Kitchen Equipment" article below for additional information.

M. Roof/Overflow Drains:
1. JR Smith
2. Mifab
3. Sioux Chief
4. Watts
5. Zurn
6. Or approved equivalent.

N. Water Closet Seats:
1. Bemis
2. Or approved equivalent.

2.02 GENERAL PLUMBING FIXTURES

A. Review substitution request requirements in Division 01, General Requirements and 22 00 00, Plumbing General Requirements.

B. Reference Architectural Details for mounting height and location of fixtures.

C. Provide factory fabricated fixtures of type, style and material indicated on the plumbing fixture connection schedule shown on the Drawings. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by manufacturer, or required for complete installation. Where more than one type is indicated, selection is installer's option; but, fixtures of same type must be furnished by a single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.

D. Provide fixtures complete with fittings, supports, fastening devices, bolt caps, faucets, valves, traps, stops and appurtenances.

E. Plumbing Fixture Flow Rates:
1. Water Closets: Single flush 1.28 GPF.
2. Lavatories in public core areas to be set for 0.5 GPM MAX. Other lavatories to be 1.0 GPM flow.
3. Sinks to be set for 1.5 gpm flow max.
4. Showers factory set at a maximum of 1.8 - 2 GPM flow.

2.03 CARRIERS

A. Wall Hung Water Closets:

1. Vertical: Zurn Z-1204-N4-XH-50 or Z-1204-ND4-XH-50 (JR Smith 230y-MS4-M12/230DY-M54-M12)
2. Horizontal: Zurn ZE-1203-N4-XH-50 or ZE-1203-ND4-XH-50 (JR Smith 220 R/L-Y-M54-M12/220DY-M5-M12)

B. Wall Hung Urinal: Zurn Z-1218-WS. (JR Smith 913)

C. Wall Hung Lavatory: Zurn Z-1231 (D). (JR Smith 700)

D. Wall Hung Service Sink: Zurn Z-1218. (JR Smith 913/914)

E. Wall Hung Drinking Fountain: Z-1225-BL (JR Smith 834-97-98)

F. 750 lb. Carrier for Water Closet:
1. Vertical Type: Zurn 1204 Series, JR Smith 250 Series
2. Horizontal Type: Zurn 1203 Series, JR Smith 210/220 Series

2.04 DOWNSPOUT BOOT/NOZZLE/COVER

A. See Schedule on Drawings for type.

2.05 DRINKING FOUNTAINS

A. See Schedule on Drawings for type.

2.06 EMERGENCY SHOWERS/EYEWASH

A. Provide emergency showers/eyewash products that are compliant with ANSSI Z358.1, Standards for Emergency Eyewashes and Shower Equipment.

2.07 FIXTURE TRIM

A. Traps: Provide heavy duty commercial grade traps on fixtures except fixtures with integral traps. Exposed traps will be chromium plated cast brass or 17 gauge chromium plated brass tubing.
1. Sink: McGuire 8912-C-DF.
2. Lavatory: McGuire 8902-C-DF.

B. Supplies and Stops: Lead free heavy duty commercial grade, chrome plated with brass stems. Stops: Loose key type.
1. Lavatory: McGuire LFH 2165 CK
2. Sink: McGuire LFH 2167 LK
3. Water Closets: McGuire

C. Grid strainer: McGuire 155A.

D. Sink strainer: McGuire 152N.

E. Trim barrier-free wrap for P-traps and supplies by McGuire, Pro-Wrap, Plumberex or True-bro.

F. Escutcheons: McGuire wrought brass deep bell.

G. Wax Rings and Toilet Bolts: WM Harvey No Seep No. 1 053065-N.

2.08 FLOOR DRAINS

A. See Schedule on Drawings for types.

2.09 FLOOR SINKS

A. See Schedule on Drawings for types.

B. Plastic components are not allowed.

2.10 FLUSHOMETERS - WATER CLOSET/URINAL

A. See Schedule on Drawings for types.

2.11 HOSE BIBBS

A. See Schedule on Drawings for types.

2.12 KITCHEN EQUIPMENT

A. No products specified. See Part 3 "Kitchen Equipment" article below for additional information.

2.13 ROOF/OVERFLOW DRAINS

A. See Schedule on Drawings for type.

B. Plastic components are not allowed.

2.14 WATER CLOSET SEATS

A. See Schedule on Drawings for type.

PART 3 EXECUTION

3.01 GENERAL PLUMBING FIXTURE INSTALLATION INFORMATION

A. Verification of Conditions:
   1. Examine rough-in work of water supply and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures.
   2. Examine walls, floors and cabinets for suitable conditions where fixtures are to be installed.
   3. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings and pertinent codes and regulations, design and referenced standards.
   4. Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.
   5. Install a stop valve in a readily accessible location in water connection to each fixture.
   6. Install escutcheons at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
   7. Seal fixtures to walls and floors using silicone sealant Dow Corning No. 780 or approved equivalent. Match sealant color to fixture color.
   8. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.
   9. Inspect each unit for damage prior to installation. Replace damaged fixtures.
   10. Replace washers or cartridges of leaking or dripping faucets and stops.
   11. Clean fixtures, trim and strainers using manufacturer's recommended cleaning methods and materials.
   12. During construction, cover installed fixtures, drains, sinks and water coolers with cardboard and wrap with sheet plastic.
   13. Provide trap primers for floor drains, floor sinks, trench drains and hub drains.
   14. Install roof and overflow roof drains per architectural details. Cover drains during roof construction to protect drain. Provide offsets or expansion joints at each roof/overflow drain.
   15. Do not use lead flashing.

B. Owner Furnished Equipment:
   1. Rough-in and make final connections to Owner furnished equipment. Provide necessary items to complete installation.
   2. Comply with requirements of this Section and Drawings for installation procedures.

C. Adjusting and Cleaning:
   1. Clean plumbing fixtures, trim, and strainers of dirt and debris upon completion of installation. Adjust water pressure at drinking fountains, faucets, shower valves and flush valves to provide proper flow stream and specified GPM. Repair leaks at faucets and stops.

D. Extra Stock:
   1. Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner.

E. Field Quality Control:

1. Upon completion of installation of plumbing fixtures, test fixtures to demonstrate capability and compliance with Specifications. Correct or replace malfunctioning units at site, then retest to demonstrate compliance.

F. Protection:
1. Protect fixtures and equipment from damage. Cover finished fixtures with cardboard and sheet plastic. Fixtures are not to be used during construction. Replace damaged items with new.

3.02 CARRIERS INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid.

C. Provide carriers rated for 750-lbs. at ADA accessible water closet locations.

3.03 DOWNSPOUT BOOT/NOZZLE/COVER INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid.

3.04 DRINKING FOUNTAIN INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid.

3.05 EMERGENCY SHOWERS/EYEWASH INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid.

3.06 FIXTURE TRIM INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid.

3.07 FLOOR DRAINS INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid.

3.08 FLOOR SINK INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid. Set fixture rim/grate flush with surrounding finish surface unless specifically noted otherwise.

3.09 FLUSHOMETERS - WATER CLOSET/URINAL INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid. Set fixture rim/grate flush with surrounding finish surface unless specifically noted otherwise.

3.10 HOSE BIBB INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid.

3.11 KITCHEN EQUIPMENT INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Furnish and install shutoff valves, pressure regulators, shock arrestors, vacuum breakers, strainers, indirect waste piping, backflow preventers, and other devices or piping which are not furnished with kitchen equipment.

C. Set plumb, level and rigid.

3.12 ROOF/OVERFLOW DRAINS INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid.

3.13 WATER CLOSET SEAT INSTALLATION

A. Install components in accordance with manufacturers instructions and approved product data submittals.

B. Set plumb, level and rigid.

END OF SECTION

SECTION 23 0000

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work included in 23 00 00, HVAC Basic Requirements applies to Division 23, HVAC work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of heating, ventilating and air conditioning systems for proposed project.

B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.

C. Definitions:
   1. Provide: To furnish and install, complete and ready for intended use.
   2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
   3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work provided.
   4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent", substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
   5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.02 RELATED SECTIONS:

A. Contents of Section applies to Division 23, HVAC Contract Documents.

B. Related Work:
   1. Additional conditions apply to this Division including, but not limited to:
      a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. 01 33 00 Delegated Design Requirements: administrative and procedural requirements for Subcontractor Bidder-Engineered items.
      b. Drawings
      c. Addenda
      d. Owner/Architect Agreement
      e. Owner/Contractor Agreement
      f. Codes, Standards, Public Ordinances and Permits

1.03 REFERENCES AND STANDARDS

A. References and Standards per Division 01, General Requirements, individual Division 23, HVAC Sections and those listed in this Section.

B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
   1. State of Oregon:
      a. OAR Oregon Administrative Rules
      b. OESC Oregon Electrical Specialty Code
      c. OFC Oregon Fire Code
      d. OMSC Oregon Mechanical Specialty Code
      e. OPSC Oregon Plumbing Specialty Code
      f. OSSC Oregon Structural Specialty Code

g. OEESC Oregon Energy Efficiency Specialty Code
h. Oregon Elevator Specialty Code

C. General: Reference standards and guidelines include but are not limited to the latest adopted editions from:
1. ABA Architectural Barriers Act
2. ABMA American Bearing Manufacturers Association
3. ADA Americans with Disabilities Act
4. AHRI Air-Conditioning Heating & Refrigeration Institute
5. AMCA Air Movement and Control Association
6. ANSI American National Standards Institute
7. ASCE American Society of Civil Engineers
8. ASHRAE American Society of Heating, Refrigeration and Air-Conditioning Engineers
9. ASHRAE Guideline 0, The Commissioning Process
10. ASME American Society of Mechanical Engineers
11. ASPE American Society of Plumbing Engineers
12. ASSE American Society of Sanitary Engineering
13. ASTM ASTM International
14. AWWA American Water Works Association
15. CFR Code of Federal Regulations
16. CGA Canadian Gas Association
17. CHPS Collaborative for High Performance Schools
18. CISPI Cast Iron Soil Pipe Institute
19. CSA CSA International
20. EPA Environmental Protection Agency
21. ETL Electrical Testing Laboratories
22. FDA Food and Drug Administration
23. FM FM Global
24. GAMA Gas Appliance Manufacturers Association
25. HI Hydraulic Institute Standards
26. IAPMO International Association of Plumbing & Mechanical Officials
27. IFGC International Fuel Gas Code
28. ISO International Organization for Standardization
29. MSS Manufacturers Standardization Society
30. NEC National Electric Code
31. NEMA National Electrical Manufactures Association
32. NFPA National Fire Protection Association
33. NFGC National Fuel Gas Code
34. NRCA National Roofing Contractors Association
35. NSF National Sanitation Foundation
36. OSHA Occupational Safety and Health Administration
37. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
38. TEMA Tubular Exchanger Manufactures Association
39. TIMA Thermal Insulation Manufactures Association
40. UL Underwriters Laboratories, Inc.
41. USDA United States Department of Agriculture

D. See Division 23, HVAC individual Sections for additional references.

E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.

F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

G. Piping and duct insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.04 SUBMITTALS

A. See Division 01, General Requirements for Submittal Procedures and Section 01 3300 Delegated Design Requirements, as well as specific individual Division 23, HVAC Sections.

B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.

C. In addition:
   1. "No Exceptions Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
   2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.
   3. Product Data: Provide Manufacturer's descriptive literature for products specified in Division 23, HVAC Sections.
   4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the Specifications and Drawings.
      a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
      b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 23, HVAC Specification Sections for specific items required in product data submittal outside of these requirements.
      c. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.
      d. For vibration isolation of equipment, list make and model selected with operating load and deflection.
      e. See Division 23, HVAC individual Sections for additional submittal requirements outside of these requirements.
   5. Maximum of two reviews of submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of these additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
   6. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet Section 23 0548, Vibration and Seismic Controls for HVAC Equipment. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Part 3 of this Section.

7. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required by Division 23, HVAC Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.
8. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
9. Substitutions and Variation from Basis of Design:
    a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
    b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.
10. Shop Drawings: Provide coordinated shop drawings which include physical characteristics of all systems, equipment, ductwork and piping layout plans, and control wiring diagrams. Reference individual Division 23, HVAC Specification Sections for additional requirements for shop drawings outside of these requirements.
    a. Provide Shop Drawings indicating access panel locations for items that require Code or maintenance access, size and elevation for approval prior to installation.
11. Samples: Provide samples when requested by individual Sections.
12. Resubmission Requirements:
    a. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
        1) Resubmit for review until review indicates no exceptions taken or make "corrections as noted".
        2) When submitting drawings for Engineers re-review, clearly indicate changes on drawings and "cloud" any revisions. Submit a list describing each change.
13. Operation and Maintenance Manuals, Owners Instructions:
    a. Submit, at one time, electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Include valve charts. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
        1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
        2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment: belts, motors, lubricants, and filters.

3) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Sections.
4) Include product certificates of warranties and guarantees.
5) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.
6) Include copy of startup and test reports specific to each piece of equipment.
7) Include copy of final air and water systems balancing log along with pump, fan and distribution system operating data.
8) Include commissioning reports.
9) Include copy of valve charts/schedules.
10) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.

b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 23 00 00, HVAC Basic Requirements Article titled "Demonstration".
c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

14. Record Drawings:
a. Maintain at site at least one set of drawings for recording “As-constructed” conditions. Indicate on drawings changes to original documents by referencing revision document, and include buried elements, location of cleanouts, and location of concealed mechanical items. Include items changed by field orders, supplemental instructions, and constructed conditions.
b. Record Drawings are to include equipment and fixture/connection schedules, control dampers, fire smoke dampers, fire dampers, valves, bottom of pipe, duct and equipment elevations and dimensioned locations for all distribution systems (hydronic and air). Invert elevations and dimensioned locations for underground systems below grade to 5-feet outside building that accurately reflect "as constructed or installed" for project.
c. At completion of project, input changes to original project Revit Model and make one set of black-line drawings created from Revit Model in version/release equal to contract drawings. Submit Revit disk and drawings upon substantial completion.
d. See Division 23, HVAC individual Sections for additional items to include in record drawings.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements: Work and materials installed to conform with all local, State, Federal and other applicable laws and regulations.

B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.

C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.

D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.

E. UL and CSA Compliance: Provide products which are UL listed.

F. ASME Compliance: ASME listed water heaters and boilers with an input of 200,000 BTUH and higher, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.

G. Provide safety controls required by National Boiler Code (ASME CSD 1) for boilers and water heaters with an input of 400,000 BTUH and higher.

1.06 WARRANTY

A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Contracting and Procurement Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.07 COORDINATION DOCUMENTS

A. Prior to construction, prepare and submit coordinated layout drawings (composite drawings), to coordinate installation and location of ductwork, grilles, diffusers, piping, fire sprinklers, plumbing, lights, and electrical services. Composite Drawings show services on single sheet. Key Drawings to structural column identification system. Prior to completion of Drawings, coordinate proposed installation with architectural and structural requirements, and other trades (including plumbing, HVAC, fire protection, electrical, ceiling suspension, and ceiling tile systems, etc.), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence. Unless otherwise required by Division 00, Procurement and Contracting Requirements and/or Division 01, General Requirements, Division 23, HVAC to combine information furnished by other trades onto master coordination documents.

B. Prepare Drawings as follows:
   1. Drawings in Revit Model. Revit Model release equal to design documents. Drawings to be same sheet size and scale as Contract Drawings and indicate location, size and elevation above finished floor of equipment and distribution systems.
   2. Review and revise, as necessary, Section cuts in Contract Drawings after verification of field conditions.
   3. Indicate hydronic and air distribution system piping including fittings, hangers, access panels, valves, and bottom of pipe and duct elevations above finished floor.
   4. Indicate inverts and provision for piping that must be graded to have right-of-way over more flexible items. Drawings also to indicate proposed ceiling grid and lighting layout as shown on electrical drawings and architectural reflected ceiling drawings and HVAC equipment, ductwork and piping.
   5. Incorporate Addenda items and change orders.
   6. Distribute drawings to trades and provide additional coordination as requested by other trades.

C. Advise Architect in event conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.

D. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.

E. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide like items from one manufacturer, including but not limited to pumps, fans, valves, control devices, air handlers, vibration isolation devices, etc.

2.02 MATERIALS

A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL approved or have adequate approval or be acceptable by State, County, and City authorities.

B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.

C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

D. Hazardous Materials:
   1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
   2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
   3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.03 ACCESS PANELS

A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.

B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 23, HVAC Sections. In absence of specific requirements in Division 01, General Requirements, comply with the following:
   1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
      a. Ceiling access panels to be minimum 24-inch by 24-inch required and approved size.
      b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
      c. Provide screwdriver operated catch.
      d. Manufacturers and Models:
         1) Drywall: Karp KDW.
         2) Plaster: Karp DSC-214PL.
         3) Masonry: Karp DSC-214M.
         4) 2 hour rated: Karp KPF-350FR.
         5) Manufacturers: Milcor, Elmdor, Acudor or approved equivalent.

PART 3 - EXECUTION

3.01 ACCESSIBILITY AND INSTALLATION

A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Install equipment having components requiring access (i.e., drain pans, drains, control operators, valves, motors and vibration isolation devices) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.

C. Install equipment and products complete as directed by manufacturer's installation instructions including all appurtenances recommended in manufacturer's installation instructions, at no

additional charge to Owner. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing and coordination with other trades and disciplines.

D. Firestopping:
   1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
      a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

E. Pipe Installation:
   1. Coordinate work to account for expansion and contraction of piping materials and building, as well as anticipated settlement or shrinkage of building. Install work to prevent damage to piping, equipment, and building and its contents. Provide piping offsets, loops, seismic flexible joints, expansion joints, sleeves, anchors or other means to control pipe movement and minimize forces on piping. Verify anticipated settlement and/or shrinkage of building. Verify construction phasing, type of building construction products and rating for coordinating installation of piping systems.
   2. Include provisions for servicing and removal of equipment without dismantling piping.

F. Plenums:
   1. Plenums: Materials within plenums shall be noncombustible or shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E 84 or UL 723. Immediately notify Architect / Engineer of any discrepancy.

G. Utility Tunnels:
   1. Contractor will coordinate with other trades for services installed within the utility tunnels. Service piping shall be installed such as to maintain a clear passage for a repairman to move and work inside the tunnels.
      a. A 24-inch cross-sectional area will be provided along all portions of the tunnel for service access. This area shall extend from the bottom to top of the tunnel.
      b. The floor shall be maintained clear from any pipe installations. Should piping be proposed for the service access area, it will be submitted as a shop drawing for review and acceptance prior to pipe installation.
      c. The utility tunnels will be left clean with no construction debris.

3.02 SEISMIC CONTROL

A. Confirm Seismic Control requirements in Division 01, General Requirements, Section 23 0548, Vibration and Seismic Controls for HVAC Equipment, Section 23 00 00, HVAC Basic Requirements and individual Division 23 HVAC Sections.

B. Equipment Importance Factor: 1.0.

C. General:
   1. Confirm Building Occupancy Category and Seismic Design Category with Structural Engineer.
   2. Earthquake resistant designs for HVAC (Division 23) equipment and distribution, i.e. motors, ductwork, piping, equipment, etc. conform to regulations of jurisdiction having authority.
   3. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure

equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.

4. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for piping equipment and water heaters. Submit Shop Drawings along with equipment submittals.
5. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details. Coordinate exact design requirements with project Structural Engineer.

D. Piping and Ductwork:
   1. Per "Seismic Restraints Manual Guidelines for Mechanical Systems" latest edition published by SMACNA or local requirements.

E. Equipment:
   1. Provide means to prohibit excessive motion of equipment during earthquake.

3.03 REVIEW AND OBSERVATION

A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
   1. Underground system installation prior to backfilling.
   2. Prior to covering walls.
   3. Prior to ceiling cover/installation.
   4. After major equipment is installed.
   5. When main systems, or portions of, are being tested and ready for inspection by AHJ.

C. Final Punch:
   1. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.04 CONTINUITY OF SERVICE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
   1. During remodeling or addition to existing structures, while existing structure is occupied, current services to remain intact until new construction, facilities or equipment is installed.
   2. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new piping and ductwork, and wiring to point of connection. Where existing systems are being utilized, clean existing distribution systems (ductwork, piping, fans, air handlers) prior to connecting new ductwork or piping.
   3. Coordinate transfer time to new service with Owner. If required, perform transfer during off peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
      a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
   4. Organize work to minimize duration of power interruption.

3.05 CUTTING AND PATCHING

A. Confirm Cutting and Patching requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
   1. Proposed floor cutting/core drilling/sleeve locations to be approved by project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to project

Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).

2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.06 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

B. Maintain design intent where equipment other than as shown as Basis of Design in Contract Documents is provided. Where equipment requires ductwork or piping arrangement, controls/control diagrams, or sequencing different from that indicated in Contract Documents, provide at no additional cost to Owner.

3.07 DELIVERY, STORAGE AND HANDLING

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
   1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced before installation. Products and/or materials that become damaged due to water, dirt, and/or dust as a result of improper storage to be replaced before installation.
   2. Protect equipment and pipe to avoid damage. Close pipe openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
   3. Protect bright finished shafts, bearing housings and similar items until in service.

3.08 DEMONSTRATION

A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.09 CLEANING

A. Confirm Cleaning requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.10 INSTALLATION

A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Do not place equipment in sustained operation prior to initial balancing of HVAC systems.

D. Provide miscellaneous supports/metals required for installation of equipment, piping and ductwork.

3.11 PAINTING

A. Confirm Painting requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
   1. Ferrous Metal: After completion of work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces in mechanical rooms, i.e., hangers, hanger rods, equipment stands, with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
   2. After acceptance by Authority Having Jurisdiction (AHJ), In a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
   3. See individual equipment Specifications for other painting.
   4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
   5. Piping and Ductwork: Clean, primer coat and paint exposed piping and ductwork on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.
   6. Covers: Covers such as manholes, cleanouts and the like will be furnished with finishes which resist corrosion and rust.

3.12 ACCESS PANELS

A. Confirm Access Panel requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
   1. Coordinate locations/sizes of access panels with Architect prior to work.

3.13 DEMOLITION

A. Confirm requirements in Division 01, General Requirements and Division 02, Existing Conditions. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
   1. Scope:
      a. It is the intent of these documents to provide necessary information and adjustments to the HVAC system required to meet code, and accommodate installation of new work.

b. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
c. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.

2. Equipment: Unless otherwise directed, equipment, fixtures, or fittings being removed as part of demolition process are Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.
3. Unless specifically indicated on Drawings, remove exposed, unused ductwork and piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap and patch surfaces to match surrounding finish.
4. Unless specifically indicated on Drawings, remove unused equipment, fixtures, fittings, rough-ins, and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).

3.14 ACCEPTANCE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
a. Testing and Balancing Reports
b. Cleaning
c. Operation and Maintenance Manuals
d. Training of Operating Personnel
e. Record Drawings
f. Warranty and Guaranty Certificates
g. Start-up/Test Document
h. Commissioning Reports

3.15 FIELD QUALITY CONTROL

A. Confirm Field Quality Control requirements in Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Tests:
1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in Operation and Maintenance Manuals.
2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.16 LETTER OF CONFORMANCE

A. Provide Letter of Conformance, copies of manufacturers' warranties and extended warranties with a statement that HVAC items were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include Letter of Conformance, copies of manufacturers' warranties and extended warranties in Operation and Maintenance Manuals.

3.17 ELECTRICAL INTERLOCKS

A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.

3.18 TEMPORARY HEATING, COOLING AND HUMIDITY CONTROL

A. Provide temporary heating, cooling, controls, humidification and dehumidification as required to facilitate the construction of the project. Size and select temporary system based on the requirements of the various trades during construction. This includes, but is not limited to, drywall, case work, wood flooring and wood finishes that are subject to warping. Size and install system to prevent mold growth. Coordinate the location of the temporary system. The house system can be used. Develop a procedure for how the house system will be used including a sketch depicting the house system, how filtration will be used to prevent construction debris from entering the system and how often the filters will be changed, how the ductwork will be cleaned after use to insure a clean system is turned over to the Owner and how the units are sized. Submit this procedure to the Mechanical Engineer for review. Follow National Air Duct Cleaners Association (NADCA) duct cleaning procedures and guidelines. Warranties for the house system, if new, to commence when the Owner moves in if house system is used as the means to maintain the climate within the building during construction. Include this warranty requirement in the original bid or proposal amount. Coordinate and provide any temporary power, controls, ductwork, piping, plumbing anchorage, miscellaneous steel and structural supports required to support the temporary system. Installation of the system to comply with all applicable codes and be acceptable to the Authority Having Jurisdiction (AHJ).

END OF SECTION

SECTION 23 0513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Starters
   2. Shaft Grounding
   3. Motors

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. NEMA Premium Efficiency
   2. Energy Policy Act (EPACT), latest applicable version(s) for minimum motor efficiencies.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Field Installed Motors: Installed motors to be of single type, from one source and from a single manufacturer.
   2. Electrical components and materials to be UL and ETL listed/labeled as suitable for location and use.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Starters:
   1. Cerus
   2. Eaton Electrical
   3. General Electric
   4. Siemens
   5. Square D
   6. Or approved equivalent.

B. Shaft Grounding:
   1. Shaft Grounding Inc.
   2. Aegis SGR Bearing Protection Ring
   3. Or approved equivalent.

C. Motors:
   1. Lincoln Motor
   2. Century Electric Motors (formerly A.O. Smith Electrical Products)
   3. Baldor Electric
   4. General Electric

5. Toshiba
6. Exception: Motors integral to equipment efficiency listing (EER, COP, etc.) per listing agency.
7. Or approved equivalent.

2.02 STARTERS

A. Single Phase Motors:
   1. Manual across-the-line starting switch having toggle-operated switch pilot running light and built-in thermal overload device with heating element rated not more than 115 percent motor full load current indicated on name plate of motor to be protected. Surface mount starters. Provide NEMA-1 enclosure.
   2. Overload relays to be melting alloy type with a replaceable control circuit module. Thermal units to be interchangeable. Starter to be non operative if thermal unit is removed.
   3. Single-phase motors with automatic controls. Provide motor-rated relay with coils rated for control voltage.

B. Starters up to Size 8 to be suitable for the addition of a minimum of three external auxiliary contacts (normally open or normally closed). Contactor, coils, and relays to perform the control functions of the associated equipment and control sequence.

C. Three Phase Motors up to and Including 15 HP:
   1. Provide enclosed type magnetic across-the-line starter with thermal overload and undervoltage protection.
   2. Operator: "Start-Stop" pushbutton, except where automatic control is indicated on Drawings or specified. Then provide "Hand-Off-Auto" selector switch.
   3. Starters for 3-phase motors to have overload protection in each of the three legs, with external manual reset.
   4. Unless indicated on Drawings or in Specifications, furnish motor starters with a neon pilot light. Neon lights are required for exhaust fan switches.
   5. Equip starters with integral transformer and coil for control circuit. Coordinate coil voltage with control voltage.

D. For Three Phase Motors Greater than 15 HP:
   1. Provide combination starter and fused safety disconnect integral in the same enclosure. Utilize Type 'RK' or 'L' fuses. Provide fuse block with rejection type fuse holders. Size fuses per motor manufacturer's recommendations.
   2. Provide a solid-state reduced voltage starter, consisting of power Section, one-piece removable printed circuit logic board and field wiring interface terminals. Logic board uses quick disconnect plug-in connectors for current transformers inputs, line-and-load voltage inputs, SCR gate firing output circuits and status panel. 3-phase current sensing via current transformers. Class 10 electronic overload protection.
   3. Motor starters to include the following protections:
      a. Inverse time running overcurrent protection.
      b. 250 percent to 500 percent current limit adjustment.
      c. Minimum and maximum voltage adjustments.
      d. Voltage stability adjustment.
      e. Single-phase protection with built-in short-time delay.
      f. Undervoltage protection with built-in short time delay.
      g. MOV surge suppression protection of SCRs rated 10 percent above the rated voltage.
      h. Phase sequence protection.
   4. Display: Door-mounted status LCD alphanumeric or LED display indicating run, undervoltage, phase loss, phase current unbalance, overcurrent trip, overtemperature, current limit, end of ramp, and incorrect phase rotation.
   5. Enclosure: NEMA 12. Operator: "Start-Stop" pushbutton, except where automatic control is indicated on Drawings or specified, then provide "Hand-Off-Auto" selector switch
   6. Input/Output Relays: Provide relays as required to provide the control sequence.
   7. UL 508 listed.

2.03 SHAFT GROUNDING

A. Variable Speed Motor Shaft Grounding: Shaft grounding ring.

2.04 MOTORS

A. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 40 degrees C environment.
   3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
   4. Built-in thermal overload protection or externally protected with separate over-load with low-voltage release or lock-out. Quick trip device on hermetically sealed motors.
   5. Service Factor: 1.15 for poly-phase motors except 1.25 for motors associated with shaft pressurization system fans and 1.35 for single phase motors.
   6. Efficiency: Provide NEMA Premium Efficiency motors.
   7. Motors used in conjunction with variable speed drives: Variable torque type matched for the full operating range of the variable frequency drive. As a minimum, motors to have Class F insulation, winding insulation rated for 1000 Volts and insulated bearings to prevent high frequency ground path. Loads not-to-exceed 80 percent of nameplate rating

B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

C. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Coordinate conductor sizes with Division 26, Electrical. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

D. Single Phase Power, Split Phase Motors:
   1. Starting Torque: Less than 150 percent of full load torque.
   2. Starting Current: Up to seven times full load current.
   3. Breakdown Torque: Approximately 200 percent of full load torque.
   4. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
   5. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

E. Single Phase Power, Permanent-Split Capacitor Motors:
   1. Starting Torque: Exceeding one fourth of full load torque.
   2. Starting Current: Up to six times full load current.
   3. Multiple Speed: Through tapped windings.
   4. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

F. Single Phase Power, Capacitor Start Motors:
   1. Starting Torque: Three times full load torque.
   2. Starting Current: Less than five times full load current.
   3. Pull-up Torque: Up to 350 percent of full load torque.
   4. Breakdown Torque: Approximately 250 percent of full load torque.
   5. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
   6. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

7. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

G. Three Phase Power, Squirrel Cage Motors:
1. Starting Torque: Between 1 and 1-1/2 times full load torque.
2. Starting Current: Six times full load current.
3. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
4. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
5. Insulation System: NEMA Class B or better. Use class F insulation when motors are controlled by a VFD.
6. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
7. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
8. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.
9. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
10. Sound Power Levels: To NEMA MG 1.
11. Weatherproof Epoxy Treated Motors: Epoxy coat windings with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
12. Nominal Efficiency: Meet or exceed NEMA Premium Efficiency rating when tested in accordance with IEEE 112.
13. Nominal Power Factor: Minimum at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Coordinate location of disconnect and starter or motor controller. Combination starter/disconnects may be used in lieu of separate items.

B. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

C. Unless otherwise indicated, motors 1-HP and larger to meet/exceed NEMA Premium Efficiency and latest EPACT.

D. Vertical in-line pump motors per NEMA MG1 vertical motor requirements.

E. Exception: Motors less than 250 watts, for intermittent service, motors furnished with equipment manufacturer's standard package equipment need not conform to these specifications.

F. Single phase motors for air compressors and pumps: Capacitor start type.

G. Motors located in exterior locations or wet air streams are to be of totally enclosed type.

H. Disconnects: Provided by Division 26, Electrical unless specified otherwise.

I. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

3.02 STARTER INSTALLATION

A. Install starters in accordance with manufacturer's instructions.

B. Coordinate disconnect requirements and location with Division 26, Electrical if not integral to starter. If starter is installed out of line of sight of motor, provide additional disconnect at motor per code.

C. Provide NEMA housing appropriate to installation location.

D. Provide supports and install securely, in neat and workmanlike manner, as specified in NECA 1.

E. Meet mounting height and accessible location requirements per local code.

F. Provide fuses for fusible switches.

G. Select and install overload heater elements in motor starters to match installed motor characteristics.

H. Single phase 120 Volt starter: if not furnished as single packaged controller/disconnect, provide contactors, relays, wiring and devices necessary to match sequence of operation for equipment.

3.03 SHAFT GROUNDING INSTALLATION

A. Shaft Grounding Installation:
   1. Provide shaft grounding assembly on motors controlled by variable frequency drive. Shaft grounding device to be in the form of brush that resides on the motor shaft. Brush assembly capable of tolerating misalignment and maintaining rotating contact throughout the motors life.
   2. Material: Material used in the grounding assembly stable material commonly used within industry that is not believed to constitute a hazardous material under Occupational Safety & Health Administration (OSHA) regulations.
   3. Brushes: Specifically developed carbon compounds of sustained performance with sear life expectancy of 3 years minimum.
   4. Seals: Sealed type to keep contaminants from entering the shaft grounding system in wet or severe environment applications.
   5. Shaft Grounding Assembly: For clean room air handling systems, use the type that contains the wear products within a special enclosure within the shaft grounding system.
   6. Shaft grounding assembly installation not to affect the motor manufacturer warranty. Where the severe environment conditions require application of the shaft grounding types that are screwed into the motor shaft, the installation of the shaft grounding system performed either by the motor manufacturer or by the motor manufacturer authorized facility.
   7. Bond the brush to the closest ground point using code sized green insulated stranded copper conductor per manufacturer instructions.
   8. Test and verify the performance of the assembly to ensure that under no conditions the shaft exceeds 3 volts.
   9. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
   10. Check line voltage and phase and ensure agreement with nameplate.
   11. Verify motor rotation.

3.04 MOTOR INSTALLATION

A. Electrical Service: Power wiring from source to motor termination under Division 26, Electrical.

B. Install in accordance with manufacturer's instructions. Coordinate with starter or variable speed controller with control sequence to provide necessary starter accessories.

C. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

D. Check line voltage and phase and ensure agreement with nameplate.

E. Verify motor rotation.

F. Field Quality Control:
   1. Prepare for acceptance tests as follows:
      a. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
      b. Test interlocks and control features for proper operation.

c. Verify that current in each phase is within nameplate rating.

2. Testing: Perform the following field quality-control testing:
   a. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.
   b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   a. Inspect field-assembled components, equipment installation, and piping and electrical connections for compliance with requirements.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   c. Verify bearing lubrication.
   d. Verify proper motor rotation.
   e. Test Reports:
      1) Prepare a written report to record the following test procedures used:
         (a) Test results that comply with requirements.
         (b) Test results that do not comply with requirements and corrective action taken to achieve compliance.

G. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

H. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION

SECTION 23 0519
METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Pressure Gauges
   2. Thermometers
   3. Dial Thermometers
   4. Separable Sockets
   5. Thermometer Wells
   6. Duct Thermometer Support Flanges
   7. Differential and Filter Pressure Gauges
   8. Pressure-Gauge Fittings
   9. Test Plugs
   10. Turbine Flowmeters

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Pressure Gauges:
   1. Dwyer Instruments, Inc.
   2. Moeller Instrument Co., Inc.
   3. Omega Engineering, Inc.
   4. Trerice
   5. Or approved equivalent.

B. Thermometers:
   1. Ashcroft
   2. Trerice
   3. Weiss
   4. Marshaltown
   5. Weksler
   6. Or approved equivalent.

C. Differential and Filter Pressure Gauges:
   1. Dwyer
   2. Or approved equivalent.

D. Turbine Flowmeters:

1. Onicon
2. Or approved equivalent.

2.02 PRESSURE GAUGES

A. ASME B40.100, phosphor-bronze bourdon type, dry type.
   1. Case: Cast aluminum, stem-mounted, flangeless.
   2. Size: 4-1/2 inch diameter.
   3. Window: Clear glass.
   4. Connector: Brass.
   5. Scale: White aluminum with black graduation and markings.
   6. Pointer: Black, adjustable.
   7. Mid-Scale Accuracy: One percent.
   8. Scale: Psi.
   9. Basis of Design: Trerice Model 600CB.

2.03 THERMOMETERS

A. Thermometers - Adjustable Angle: Red-or blue-appearing organic liquid in glass: ASTM E 1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
   1. Size: 9-inch scale.
   2. Window: Acrylic.
   3. Scale: Aluminum, white background, black graduations and markings.
   4. Stem: 3/4-inch NPT brass (aluminum for installation in air ducts).
   5. Accuracy: 2 percent, per ASTM E 77.
   6. Calibration: 0-160 with 2 Degrees F. graduations.
   7. Basis of Design: Trerice BX9.

2.04 DIAL THERMOMETERS

A. Thermometers: ASTM E 1, cast aluminum case, vapor or liquid actuated with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer, glass lens, adjustable 360 degrees in horizontal plane. 180 degrees in vertical plane.
   1. Size: 4-1/2-inch diameter dial.
   2. Lens: Clear glass.
   3. Length of Capillary: Minimum 6-feet (for remote reading if required).
   4. Accuracy: 2 percent.
   5. Calibration: 2 Degrees F. graduations.
   6. Basis of Design: Trerice Model 80742.

2.05 SEPARABLE SOCKETS

A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.
   1. Material: Brass, for use in copper piping.
   2. Material: Stainless steel, for use in steel piping.
   3. Extension-Neck Length: Nominal thickness of 2-inches, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
   4. Insertion Length: To extend to center of pipe.
   5. Cap: Threaded, with chain permanently fastened to socket.
   6. Heat Transfer Fluid: Oil or graphite.

2.06 THERMOMETER WELLS

A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.
   1. Material: Brass for use in copper piping.
   2. Material: Stainless steel, for use in steel piping.

3. Extension Neck Length: Nominal thickness of 2-inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
4. Insertion Length: To extend to center of pipe.
5. Cap: Threaded, with chain permanently fastened to socket.
6. Heat Transfer Fluid: Oil or graphite.

2.07 DUCT THERMOMETER SUPPORT FLANGES

A. Description: Flanged fitting bracket for mounting in hole of duct, with threaded end for attaching thermometer.
   1. Extension Neck Length: Nominal thickness of 2-inches, but not less than thickness of exterior insulation.
   2. Insertion-Neck Length: Nominal thickness of 2-inches, but not less than thickness of insulation lining.

2.08 DIFFERENTIAL AND FILTER PRESSURE GAUGES

A. Service: Air and non-combustible, compatible gases (Natural Gas option available.)

B. Wetted Materials: Consult factory.

C. Housing: Die cast aluminum case and bezel, with acrylic cover. Exterior finish is coated gray to withstand 168 hour salt spray corrosion test.

D. Accuracy: Plus or minus 2 percent of full scale throughout range at 70 degrees F.

E. Pressure Limits: Minus 20 Hg to 15 PSIG.

F. Overpressure: Relief plug opens at approximately 25 PSIG standard gauges only.

G. Temperature Limits: 20 to 140 degrees F.

H. Size: 4-inch diameter dial face.

I. Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientation.

J. Process Connections: 1/8-inch female NPT duplicate high and low pressure taps, one pair side and one pair back.

K. Standard Accessories: Two 1/8-inch NPT plugs for duplicate pressure taps, two 1/8-inch pipe thread to rubber tubing adapter and three flush mounting adapters with screws.

2.09 PRESSURE-GAUGE FITTINGS

A. Valves: NPS 1/4 (DN8) brass or stainless-steel needle type.

B. Syphons: NPS 1/4 (DN8) coil of brass turbine with threaded ends.

C. Snubbers: ASME B40.5, NPS 1/4 (DN8) brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.10 TEST PLUGS

A. Description: Nickel-plated, brass-body test plug in NPS 1/2 (DN15) fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 PSIG (3450 kPa) minimum.

D. Core Inserts: One or two self-sealing valves, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gauge.

E. Core Material for Air, Water, Oil and Gas: 20 to 200 degrees F (Minus 7 to plus 93 Degrees Celsius), chlorosulfonated polyethylene synthetic rubber.

F. Test Plug Cap: Gasketed and threaded cap, with retention chain or strap.

G. Test Kit: Pressure gauge and adapter with probe, two bimetal dial thermometers, and carrying case.
   1. Pressure Gauge and Thermometer Ranges: Approximately two times the system's operating conditions.

2.11 TURBINE FLOWMETERS

A. Description: Insertion type, measures flow directly in gallons per minute (liters per second).
   1. Construction: Stainless steel body and plastic turbine or impeller, with integral direct-reading scale.
   2. Pressure Rating: 150 PSIG (1035) kPa minimum.
   3. Temperature Rating: 180 degrees F minimum.
   4. Display: Visual instantaneous rate of flow.
   5. Accuracy: Plus or minus 2 percent.
   6. Basis of Design:
      a. Onicon F-1300 - Small Pipe.
      b. Onicon F-1100 - Standard.
      c. Onicon F-1200 - Short Pipe Lengths.
      d. Onicon F-1200B - Bi-Directional.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2-inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

B. Where adequate space is not available, use turbine flow meters specifically designed for short pipe lengths. Use bi-directional turbine flow meters where indicated on piping diagrams.

C. Install turbine meters in accordance with manufacturer's instructions, and as shown on drawings. Provide recommended upstream and downstream straight pipe length for accurate reading.

D. Temperature Gauges:
   1. Install in vertical upright position, tilted so as to be easily read at floor.
   2. Thermometer Wells: Install in piping in vertical upright position. Fill well with oil or graphite, secure cup.

E. Pressure Gauges:
   1. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position, visible from floor.
   2. Locations: Install in the following locations as a minimum, and elsewhere as indicated.
      a. At each pump inlet and outlet.
      b. At inlet and discharge of each pressure reducing valve.
      c. At makeup water service outlets.
      d. At inlet and discharge of each chiller and boiler.

F. Provide instruments with scale ranges selected according to service with largest appropriate scale.

G. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

H. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

I. Locate test plugs adjacent to thermometers and thermometer sockets, adjacent to pressure gauges and pressure gauge taps, adjacent to control device sockets, or where indicated in piping diagram. Coordinate installation of thermometer and sensor wells in piping with district's controls installer.

J. Thermometer Range/Graduations:

System	Temperature (degree F)	Graduations (degrees F)
Hydronic Piping Systems	30-240	2

K. Pressure Gauge Range/Graduations:

System	Pressure (PSI)	Graduations (PSI)
Hydronic Piping Systems	0-100	1

END OF SECTION

SECTION 23 0523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Valves, General
   2. Balancing Valves
   3. Ball Valves
   4. Butterfly Valves
   5. Swing Check Valves

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. As listed in Articles below.

B. Or approved equivalent.

2.02 VALVES - GENERAL

A. General:
   1. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
   2. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6-inches and smaller. Provide gear operators for quarter-turn valves 8-inches and larger and plug valves 5-inches and larger. Provide chain-operated sheaves and chains for overhead valves installed over 5-feet above finished floor.
   3. Valve Identification: Manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

B. Valves in Insulated Piping: With 2-inch stem extension and following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied.
      a. Basis of Design Product: Subject to compliance with requirements. Provide NIBCO Nib-seal handle extension or comparable product by one of the following.
         1) Conbraco Industries, Inc.: Apollo Div.
   2. Butterfly Valves: With extended neck.

C. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves, ASME B16.5 for steel valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With thread according to ASME B1.20.1.

D. Valve Bypass and Drain Connections: MSS SP-45.

E. Building Service:
1. Shutoff and Isolation Valves:
a. Pipe Sizes 3-inches and Smaller: Ball valve.
b. Pipe Sizes 4-inches and Larger: Butterfly valve.
2. Drain Service; All Pipe Sizes: Ball valves.
3. Strainer Blow-Off: Ball valve.
4. Check Valves: Swing.

F. Manufacturers: Crane, Griswold, Hammond, Hays, Jenkins, Milwaukee, Mueller, Nibco, Stockham, Tour Anderson, Watts. Note: See individual Sections for specialty valves (balancing valves, pressure regulators, relief valves, earthquake valves, gas valves). NIBCO Numbers shown as Basis of Design.

2.03 BALANCING VALVES

A. Maximum 125 PSIG System Working Water Pressure.

B. Manual Set Balancing Valves:
1. Valves are to be of the "Y" pattern, equal percentage globe-style and provide three functions:
a. Precise flow measurement.
b. Precision flow balancing.
c. Positive drip-tight shut-off.
2. Valve to provide multi-turn, 360 degree adjustment with micrometer type indicators located on the valve handwheel. Valves have a minimum of five full 360 degree handwheel turns. 90 degree style ball valves are not acceptable. Valve handle to have hidden memory feature, which will provide a means for locking the valve position after the system is balanced. Valves to be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi to have two 1/4-inch threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve. The valve body, stem and plug to be brass. The handwheel to be high-strength resin.
3. 2-1/2-inches and Larger: Valve body to be either cast iron with integrated cast iron flanges (2-1/2-inch to 12-inch) or ductile iron with industrial standard grooved ends (2-1/2-inch to 12-inch). Valve stem and plug disc to be bronze with handwheel that permits multi-turn adjustments. Sizes 2-1/2-inch and 3-inch - five turns, sizes 4-inch to 6-inch - 6 turns, sizes 8-inch to 10-inch - 12 turns and size 12-inch - 14 turns. Flange adapters to be provided to prevent rotation.
4. Manufacturers: Armstrong CBV, Tour and Anderson, American Wheatley or approved equivalent

2.04 BALL VALVES

A. 2-1/2-inches and Smaller: MSS SP-110-80, 150 PSI, bronze body, threaded ends, brass or stainless steel ball, Teflon seat, bronze stem, extended steel handle, full port. Nibco T-595-Y.

B. Full Port Ball Valve: 2- to 4- inch ductile iron, ASTM A536, micro finish steel chrome plated or stainless steel ball and stem. TFE seats, 600 PSI.

2.05 BUTTERFLY VALVES

A. Select lug type valves.

B. 6-inches and Smaller: 200 PSI, ductile iron body, extended neck, stainless steel stem with aluminum bronze disc, reinforced resilient EPDM seat, memory stop control, lever handle through 5-inches, size and worm gear operator for 6-inches and larger. Mount stem in

horizontal position. Manual lever and lock Nibco LD2000, for mechanical coupling fittings. MSS SP-67, Type 1.

2.06 SWING CHECK VALVES

A. 2-inches and Smaller: Class 125, bronze body, horizontal swing, regrinding type, Y-pattern, renewable disc. Nibco 413. MSS SP-80, Type 4.

B. 2-1/2-inches and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends. Nibco F918. MSS SP-71, Type 1.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and weld ends.
   3. Set ball open to minimize exposure of functional surfaces.
   4. Set butterfly valves closed or slightly open.
   5. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Do not attempt to repair defective valves; replace with new valves.

E. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate Sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

F. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose end adapter and cap on chain for each valve that must be installed with stem below horizontal plane. Ensure installation provides full stem movement.

G. Insulation: Where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.

H. Mechanical Actuators: Install with chain operators where indicated. Extend chains to 5-feet above floor and hook to clips to clear aisle passage.

I. Stem Selection: Outside screw and yoke stems, except provide inside screw, nonrising stem where space prevents full opening of OS&Y valves.

J. Seats: Renewable seats, except where otherwise indicated.

K. Boiler isolation valves with adjustable packing gland per CSD-1.

L. Installation of Check Valves:
   1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow. Only install where there is ten pipe diameters of straight pipe upstream of valve.

3.02 VALVE ADJUSTING AND CLEANING

A. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.

B. Valve Identification: Tag valves per Section 23 05 53, Identification for HVAC Piping, Ductwork and Equipment.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball or butterfly valves.

2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: Balancing valves.
4. Pump-Discharge Check Valves:
   a. 2-inches and Smaller: Swing check valves with bronze disc.
   b. 2-1/2-inches and Larger: Swing check valves with lever and weight or with spring or wafer - seat check valves.
5. Provide isolation valve, check valve, and balancing valve on discharge side of base mounted centrifugal pumps. Combination triple duty valves not allowed. Provide isolation valve and strainer on suction side of pump.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Valves, except wafer types, with the following end connections.
1. For Copper Tubing: 2-inches and Smaller. Threaded ends.
2. For Copper Tubing: 2 1/2-inches to NPS 4-inches. Flanged ends.
3. For Copper Tubing: 5-inches and Larger: Flanged ends.
4. For Steel Piping: 2-inches and Smaller: Threaded ends.
5. For Steel Piping: 2 1/2-inches to NPS 4-inches: Flanged ends.
6. For Steel Piping:, 5-inches and Larger: Flanged ends.

3.04 PRESSURE REGULATING

A. Provide inlet and outlet ball valves, and globe valve bypass. Provide pressure gauge on valve outlet.

3.05 BALANCING VALVES

A. Install with flow in the direction of the arrow on the valve body and installed at least five pipe diameters downstream from any fitting, and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream from the balancing valve should be free of any fittings. When installed, easy and unobstructed access to the valve handwheel and metering ports for adjustment and measurement are to be provided. Mounting of valve in piping must prevent sediment build-up in metering ports. Install devices in accordance with manufacturer's recommendations to automatically balance water flow in piping loops as indicated.

B. For venturi valves less than 1-1/2-inch pipe size, provide valve sized for flow to coil. Provide transitions on both inlet and outlet of valve if valve is less than line size.

END OF SECTION

SECTION 23 0529

HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Hangers and Supports
   2. Pipe Hangers and Supports
   3. Building Attachments
   4. Flashing
   5. Miscellaneous Metal and Materials

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. ASCE 7-10, Minimum Design Loads for Buildings and Other Structures.
   2. Terminology: As defined in MSS SP-90 "Guidelines on Terminology for Pipe Hangers and Supports".
   3. Install ductwork and piping per SMACNA's requirements.
   4. Hanger spacing installation and attachment to meet all manufacturers requirements and Code requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Welding:
      a. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications.
   2. Welding for Hangers:
      a. Qualify procedures and personnel according to AWS D9.1, Sheet Metal Welding Code for duct joint and seam welding.
   3. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, duct support equipment hangers/supports, and seismic restraint by a qualified Structural Professional Engineer.
      a. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.
   4. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems, whose products have been in satisfactory use in similar service for not less than 10 years.
   5. Support systems to be supplied by a single manufacturer.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 PERFORMANCE REQUIREMENTS

A. General - Provide pipe, ductwork and equipment hangers and supports in accordance with the following:
   1. When supports, anchorages, and seismic restraints for equipment, and supports, anchorages, and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor is responsible for their design.
   2. Connections to structural framing not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Engineered Support Systems:
   1. Support frames such as pipe racks or stanchions for piping,ductwork and equipment which provide support from below.
   2. Equipment, ductwork and piping support frame anchorage to supporting slab or structure.

C. Provide channel support systems, for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

D. Provide heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

E. Provide seismic restraint hangers and supports for piping, ductwork and equipment. See Section 23 0548.

F. Obtain approval from AHJ for seismic restraint hanger and support system to be installed for piping and equipment. See Section 23 0548.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Hangers and Supports:
   1. Anvil International
   2. B-Line Systems, Inc.
   3. Erico Co., Inc.
   4. Nelson-Olsen Inc.
   5. Rilco Manufacturing Co., Inc.
   6. Unistrut corp.
   7. Or approved equivalent.

B. Pipe Hangers and Supports:
   1. Anvil International
   2. B-Line Systems, Inc.
   3. Erico Co., Inc.
   4. Nelson-Olsen Inc.
   5. Rilco Manufacturing Co., Inc.
   6. Snappitz Thermal Pipe Shield Manufacturing
   7. Unistrut corp.
   8. Or approved equivalent.

C. Building Attachments:
   1. Anchor-It
   2. Gunnebo Fastening Corp.
   3. Hilti Corporation
   4. ITW Ramset/Red Head
   5. Masterset Fastening Systems, Inc.
   6. Or approved equivalent.

D. Flashing:
   1. Manufacturer not applicable.

E. Miscellaneous Metal and Materials:
   1. Manufacturer not applicable.

2.02 HANGERS AND SUPPORTS

A. Hanger Rods:
   1. Hanger rods continuously threaded or threaded ends only in concealed spaces and threaded ends only in exposed spaces; finish electro-galvanized or cadmium-plated in concealed spaces and prime painted in exposed spaces; sizes per MSS.

B. Hanger Rod Couplings:
   1. Anvil Figure 136, B-Line Figure B3220, or approved equivalent; malleable iron rod coupling with elongated center sight gap for visual inspection; to have same finish as hanger rods.

C. Channel Hanging System:
   1. Channel Type Pipe Hanging System: Framing members No. 12 gauge formed steel channels, 1-5/8-inch square, conforming to ASTM A570 GR33, one side of channel to have a continuous slot within turned lips; framing nut with grooves and spring 1/2-inch size, conforming to ASTM 675 GR60; screws conforming to ASTM A307; fittings conforming to ASTM A575; parts enamel painted or electro-galvanized.
   2. Concrete Inserts: Malleable iron body, hot tipped galvanized finish. Lateral adjustment. MSS Type 18.

D. Continuous Concrete Insert: Steel construction, minimum 12 gauge. Electrogalvanized finish. Pipe clamps and insert nuts to match.

2.03 PIPE HANGERS AND SUPPORTS

A. Pipe Hangers:
   1. Pipe Rings for Hanger Rods: Pipe sizes 2-inch and smaller, Adjustable swivel ring hanger, UL listed. Erico 100 or 101, Anvil Figures 69 or 104, or approved equivalent. Pipe sizes 2-1/2-inches and larger, clevis type hangers with adjustable nuts on rod, UL listed. Anvil figure 260, Erico 400, or approved equivalent. Pipe hangers to have same finish as hanger rods.

B. Pipe Saddles and Shields:
   1. Factory fabricated saddles or shields under piping hangers and supports for insulated piping.
   2. Size saddles and shields for exact fit to mate with pipe insulation. 1/2 round, 18 gauge, minimum 12-inches in length (4-inch pipe and larger to be three times longer than pipe diameter).

C. Riser Clamps:
   1. Steel, UL listed. MSS Type 8. Erico 510 or 511. Copper coated; Erico 368.

D. Pipe Slides:
   1. Anvil, reinforced Teflon slide material (3/32-inch minimum thickness) bonded to steel; highly finished steel or stainless steel contact surfaces to resists corrosion; 60-80 PSI maximum active contact surface loading; steel parts 3/16-inch minimum thickness; attachment to pipe and framing by welding.

E. Pipe Guides:
   1. Furnish and install pipe guides on continuous runs where pipe alignment must be maintained. Minimum two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides securely to pipe and structure. Contact with chilled water pipe not to permit heat to be transferred in sufficient quantity to cause condensation on any surface.
   2. Furnish and install guides approximately 4 pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Guides are not to be sued as supports and are in addition to other pipe hangers and supports.

F. Pipe Roller Hangers:
   1. Adjustable roller hanger. Black steel yoke, cast iron roller. MSS Type 41.

G. Thermal Hanger Shield Inserts:

1. 100-PSI (690-kPa) minimum compressive strength calcium silicate insulation, encased in sheet metal shield or polyisocyanurate rigid foam exceeding the load bearing weight of the pipe at the hanger point with a PVC vapor barrier.
2. Material for Cold Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with vapor barrier or polyisocyanurate rigid foam with a PVC vapor barrier.
3. Material for Hot Piping: Water-repellent-treated ASTM C533, Type 1 calcium silicate or polyisocyanurate rigid foam with a PVC vapor barrier.
4. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
5. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
6. Insert Length: Extend 2-inches beyond sheet metal shield for piping operating below ambient air temperature.
7. Thermal hanger shield insulation operating temperature: Meet or exceed fluid temperature in pipe.

H. Freestanding Roof Supports:
1. Polyethylene high-density UV resistant quick "pipe" block with foam pad.

2.04 BUILDING ATTACHMENTS

A. Beam Clamps:
1. MSS Type 19 and 23, wide throat, with retaining clip.
2. Universal Side Beam Clamp: MSS Type 20.

B. Powder-Actuated Drive Pin Fasteners:
1. Powder-Actuated Drive-Pin Fasteners: Powder actuated type, drive pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

C. Anchor Bolts:
1. General: Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project structural engineer. Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
2. Anchor Bolts (Cast-In-Place): Steel bolts, ASTM A307. Nuts to conform to ASTM A194. Design values for shear and tension not more than 80 percent of the allowable listed loads.
3. Anchor (Expansion) Bolts: Carbon steel to ASTM A307; nut to conform to ASTM A194; drilled-in type. Design values for shear and tension not more than 80 percent of the allowable listed loads.
4. Anchor (Adhesive) Bolts: Consisting of two-part adhesive cartridge and zinc-plated Type A307 steel anchor bolt rod assembly with ASTM A194 nut.

2.05 FLASHING

A. Steel Flashing: 26 gauge galvanized steel.

B. Safes: 8 mil thick neoprene.

C. Caps: Steel, 22 gauge minimum, 16 gauge at fire-resistant structures.

2.06 MISCELLANEOUS METAL AND MATERIALS

A. Miscellaneous Metal: Provide miscellaneous metal items specified hereunder, including materials, fabrication, fastenings and accessories required for finished installation, where indicated on drawings or otherwise not shown on drawings that are necessary for completion of the project. The Contractor is responsible for their design.
1. Fabricate miscellaneous units to size shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.

B. Structural Shapes: Where miscellaneous metal items are needed to be fabricated from structural steel shapes and plates, provide members constructed of steel conforming with requirements of ASTM A36 or approved equivalent.

C. Steel Pipe: Provide seamless steel pipe conforming to requirements of ASTM A53, Type S, Grade A, or Grade B. Weight and size required as specified.

D. Fasteners: Provide fasteners of types as required for assembly and installation of fabricated items; surface-applied fasteners are specified elsewhere.

E. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.

F. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.

G. Provide hot dipped galvanized components for items exposed to weather. Use materials compatible with system being supported (i.e. aluminum for aluminum ductwork, stainless steel for stainless steel ductwork).

H. Use straps, threshold rods and wire with sizes required by SMACNA to support ductwork.

I. Grout: ASTM C1107, Grade B, factory mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
   1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
   2. Properties: Nonstaining, noncorrosive, and non gaseous.
   3. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Verify building materials to have hangers and attachments affixed in accordance with hangers to be used. Provide supporting calculations.

B. Examine Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall," "2-Hour Fire/Smoke Barrier," and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.

C. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate proper placement of inserts, anchors and other building structural attachments.

D. Equipment Clearances: Do not route ductwork, equipment, or piping through electrical rooms, elevator equipment rooms, IT rooms, or other electrical or electronic equipment spaces and enclosures and the like. Within equipment rooms, provide minimum 3-feet lateral clearance from all sides of electric switchgear panels. Do not route ductwork, equipment, or piping above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with Electrical and coordinate exact ductwork, equipment or pipe routing to provide proper clearance with such items.

3.02 HANGERS AND SUPPORTS INSTALLATION

A. Hang rectangular sheet-metal ducts with a cross Sectional area of less than 7 SF with galvanized strips of No. 16 USS gauge steel 1-inch wide, and larger ducts with steel angles and adjustable hanger rods similar to piping hangers. Support at a maximum of 8-feet on center.

B. Support horizontal ducts within 24-inches of each elbow and within 48-inches of each branch intersection.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Use double nuts and lock washers on threaded rod supports.

E. Floor supports in mechanical rooms to be elevated 1-inch above finish floor and void space filled with masonry grout.

F. Anchor ducts securely to building in such a manner as to prevent transmission of vibration to structure. Do not connect duct hanger straps to roof deck. Do not support ducts from other ducts, piping or equipment.

G. Attach strap hangers installed flush with end of sheet-metal duct run to duct with sheet-metal screws.

H. Construct exterior ductwork or ductwork which is otherwise exposed to weather watertight and slope 1/4-inch per foot to avoid standing water.

I. Exposed ductwork hung in clean areas such as sanitary areas, pharmaceutical areas, wash down areas or food process areas to be installed using double end, food grade trapeze hanger rods suitable for use with food grade strut.

J. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
   1. Field assemble and install according to manufacturer's written instructions.

K. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping, ductwork and equipment to proper level and elevations.

O. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.

3.03 PIPE HANGERS AND SUPPORTS INSTALLATION

A. Horizontal Piping Hangers and Supports - Horizontal and Vertical Piping, and Hanger Rod Attachments:
   1. Factory fabricated horizontal piping hangers and supports complying with MSS SP-58, to suit piping systems and in accordance with manufacturer's published product information.
   2. Use only one type by one manufacturer for each piping service.
   3. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.
   4. Pipe support spacing (pipe supported in ceiling or floor-supported) to meet latest applicable Code and manufacturer's requirements.
   5. Provide copper-plated hangers and supports for uninsulated copper piping systems.

B. Plumbers Tape not permitted as pipe hangers or pipe straps.

C. Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure. For horizontally hung grooved-end piping, provide a minimum of 2 hangers per pipe Section.

D. Pipe Ring Diameters:
   1. Uninsulated and Insulated Pipe, except where oversized pipe rings are specified: Ring inner diameter to suit pipe outer diameter.
      a. Insulated Piping Where Oversized Pipe Rings are Specified and Vibration Isolating Sleeves: Ring inner diameter to suit outer diameter of insulation or sleeve.

E. Oversize Pipe Rings: Provide oversize pipe rings of 2-inch and larger size.

F. Pipe Support Brackets: Support pipe with pipe slides.

G. Steel Backing in Walls: Provide steel backing in walls to support fixtures and piping hung from steel stud walls.

H. Pipe Guides:
   1. Install on continuous runs where pipe alignment must be maintained. Minimum two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides to pipe structure. Contact with chilled water pipe does not permit heat to be transferred in sufficient quantity to cause condensation on any surface.
   2. Install approximately 4 pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Do not use as supports. Provide in addition to other required pipe hangers and supports.

I. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field fabricated, heavy-duty trapezes.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

J. Group parallel runs of horizontal piping to be supported together on trapeze-type hangers. Maximum spacings: MSS SP-58.

K. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe.

L. Do not support piping from other piping.

M. Fire protection piping will be supported independently of other piping.

N. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping" is not exceeded.

P. Insulated Piping:
   1. Attach clamps and spacers to piping.
   2. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   3. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   4. Do not exceed pipe stress limits according to ASME B31.9.
   5. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   6. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
   7. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields to span arc of 180 degrees.
   8. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
   9. Shield Dimensions for Pipe, not less than the following:
   10. NPS 1/4 to NPS 3-1/2 (DN8 to DN 90): 12-inches long and 0.048-inch thick.
   11. NPS 4 (DN100): 12-inches long and 0.06-inch thick.
   12. NPS 5 and NPS 6 (DN125 and DN150): 18-inches long and 0.06-inch thick.
   13. Pipes NPS 8 (DN200) and Larger: Include wood inserts.
   14. Insert Material: Length at least as long as protective shield.
   15. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

Q. Pipe Anchors:
   1. General: Provide anchors to fasten piping which is subject to expansion and contraction, and adjacent to equipment to prevent loading high forces onto the equipment.

R. Pipe Curb Assemblies:
   1. Provide prefabricated units for roof membrane and insulation penetrations related to equipment. Coordinate with roofing system. Set supports on the structural deck. Do not set supports on insulation or roofing. Provide level supports by prefabricated pitch built into the curb.
      a. Pipe Curb Assemblies: Provide for piping and electrical conduit which penetrates the structural roof deck to service equipment above the roof level (i.e., piping, electrical power and control wiring). Meet requirements of roof warranty.

S. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor walls, and through equipment room walls and floors.

T. Vertical Piping:
   1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
      a. Riser clamps to be directly under fitting or welded to pipe.
         1) Riser to be supported at each floor of penetration.
         2) Provide structural steel supports at the base of pipe risers. Size supports to carry forces exerted by piping system when in operation.

U. Piping above roof to be supported with freestanding roof pipe supports unless detailed otherwise.

3.04 BUILDING ATTACHMENTS INSTALLATION

A. Factory fabricated attachments complying with MSS SP-58, selected to suit building substructure conditions and in accordance manufacturer's published product information.

B. Select size of building attachments to suit hanger rods.

C. Install concrete inserts before placing concrete.

D. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

E. Do not use powder-actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4-inches thick.

F. Install within concrete or on structural steel or wood. Attachment to Wood Structure: Anvil side beam bracket Figure 202 for attachment to wooden beam or approved attachment for a wood structure.

G. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.

H. Install concrete inserts before concrete is placed; fasten insert secure to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.

I. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-58. Install additional attachments at concentrated loads, including valves, flanges guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

K. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

L. Bolting:

1. General: Provide bored, drilled or reamed holes for bolting to miscellaneous structural metals, frames or for mounts or supports. Flame cut, punched or hand sawn holes will not be accepted.

M. Anchor Bolts:
1. General: Install anchor bolts for mechanical equipment, piping and ductwork as required. Tightly fit and clamp base-supported equipment anchor bolts at equipment support points. Provide locknuts where equipment, piping and ductwork are hung.
2. Anchor bolts (Cast-In-Place): Embed anchor bolts in new cast-in-place concrete to anchor equipment. Install a pipe sleeve around the anchor bolt for adjustment of the top 1/3 of the bolt embedment; sizes and patterns to suit the installation conditions of the equipment to be anchored.

N. Testing: Test powder-actuated insert attachments with a minimum load of 100 pounds.

3.05 FLASHING INSTALLATION

A. Flash and counterflash where piping, ductwork and equipment passes through weather or waterproofed walls, floors, and roofs.

B. Provide 12-inches minimum height curbs for roof-mounted mechanical equipment. Flash and counter flash with galvanized steel, soldered and waterproofed.

3.06 MISCELLANEOUS METAL AND MATERIALS INSTALLATION

A. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates, and similar devices. Hot dipped galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.

B. Finishes:
1. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with 1 coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas in primer with same material, before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.
2. Metal in Contact with Concrete, Masonry and Other Dissimilar Materials:
a. Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
3. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

C. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws

and other connectors as required. Avoid cutting concrete reinforcing when drilling for inserts. Reference structural drawings and reinforcing shop drawings and determine locations of stirrups prior to drilling into concrete.

E. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items, which are to be built into concrete masonry or similar construction.

F. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

G. Setting Loose Plates: Clean concrete and masonry bearing surfaces of any bond reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.

H. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut-off flush with edge of the bearing plate before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated.

I. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

J. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

K. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

L. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

M. Provide galvanized components for items exposed to weather.

END OF SECTION

SECTION 23 0533
HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Heat Trace Cable (Freeze Protection).

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
   1. Section 23 07 00, HVAC Insulation
   2. Section 26 00 00, Electrical Basic Requirements

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. UL 718K, Pipe Heating Cable.
   2. CSA 3A, 3B, and 3C.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Project Record Documents: Record physical locations of thermostats.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Minimum heat tape capacities per linear foot as scheduled on Drawings.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Heat Trace Cable (Freeze Protection):
   1. Thermon/FLX
   2. Chromalox/SRF
   3. Raychem/XL-Trace
   4. Nelson/CLT
   5. Or approved equivalent.

2.02 HEAT TRACE CABLE (FREEZE PROTECTION)

A. General: Provide complete UL listed system of heating cables and components listed specifically for maintaining pipe temperature over entire piping system exposed to freezing temperatures.

B. Materials
   1. Cable: Self-regulating flat, flexible, low-heat density, parallel electric heater strip consisting of 2 stranded circuit conductors enclosed in semi-conductive, polymer core insulated with plastic jacket protected with tinned-copper braid. Ability to overlapped without creating hot spots and suitable for application on plastic, copper or steel pipe.

2. Voltage: See Electrical Drawings. Provide power connections, end seals, splices tap-offs and tees for a complete system.
3. Controls: Thermostat with fixed setpoint of 40 degrees F, remote bulb and capillary sensor enclosed in a NEMA 4 enclosure.

C. Minimum Exposure Temperature: 150 degrees F continuous.

PART 3- EXECUTION

3.01 HEAT TRACE CABLE INSTALLATION

A. Heat Trace (Freeze Protection):
1. Location: Provide heat trace on piping exposed to freezing conditions.
2. Install cable parallel to pipe or spiral wrap to achieve power density per linear foot of pipe to prevent freezing.
3. Attach heat trace cable to pipe with polyester tape; increments not exceeding 1'-0-inches.
4. Install thermostat capillary and bulb to pipe with polyester tape assuring a firm bulb contact with pipe. Install bulb without contact to heat cable. Maximum 12-inch spacing between tape.
5. Install thermostat at accessible location adjacent to pipe with minimum of exposed capillary.
6. Labeling: Provide “Electric Traced” label to outside of the pipes thermal insulation on alternating sides. Locate labels at intervals of 5 to 15-feet over entire length of heat tracing.
7. Coordinate installation with work under Division 26, Electrical for electrical service to each thermostat.
8. Coordinate application of heat tape with pipe insulation and weather jacketing.

END OF SECTION

SECTION 23 0548

VIBRATION AND SEISMIC CONTROLS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Vibration Isolation
   2. Seismic Restraint Devices
   3. Vibration Isolation Equipment Bases
   4. Factory Finishes
   5. Seismic-Bracing/Restraint Devices/Systems for Equipment, Piping, and Ductwork

B. General:
   1. Vibration isolation for mechanical ductwork, piping, and equipment.
   2. Seismic restraint for mechanical ductwork, piping, and equipment.
   3. Seismic Certification for equipment, hangers and systems
   4. Special inspections for systems.

C. Scope of Work:
   1. Vibration isolation and seismic restraint of new equipment and systems within project boundary defined in architectural drawings.
   2. Provide supplementary structural steel for seismic restraint systems.
      a. No hanging from roof deck is permitted on this project, unless specifically allowed by Structural Engineer of Record in writing prior to bid.

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Vibration Isolation:
      a. Product data: Provide catalog data indicating size, type, load and deflection of each isolator; and percent of vibration transmitted based on lowest disturbing frequency of equipment.
      b. Shop Drawings: Showing complete details of construction for steel and concrete bases including:
         1) Fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
         2) Equipment mounting holes.
         3) Dimensions.
         4) Size and location of concrete and steel bases and curbs.
         5) Isolation selected for each support point.
         6) Details of mounting brackets for isolator.
         7) Weight distribution for each isolator.
         8) Details of seismic snubbers.
         9) Code number assigned to each isolator.
      c. Design calculations: Provide calculations for selecting vibration isolators and for designing vibration isolation bases.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Seismic Restraint:
   a. Shop Drawings: Show compliance with requirements of Quality Assurance article of this Section. Shop drawings to be stamped by a professional Structural Engineer licensed in State of Oregon.
   b. Calculations: Submit seismic calculations indicating restraint loadings resulting from design seismic forces. Include anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Calculations certified by professional Structural Engineer licensed in State of Oregon.
4. Seismic Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
5. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y and z planes.
6. Welding certificates.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Vibration Isolation:
      a. Except for packaged equipment with integral isolators, single manufacturer selects and furnishes isolation required.
      b. Deflections indicated on drawings are minimum actual static deflections for specific equipment supported.
      c. Isolator Stability:
         1) Size springs of sufficient diameter to maintain stability of equipment being supported. Spring diameters not less than 0.8 of compressed height at rated load.
         2) Springs have minimum additional travel to solid equal to 50 percent of rated defection.
         3) Springs support 200 percent of rated load, fully compressed, without deformation or failure.
      d. Maximum Allowable Vibration Levels: Peak vibration velocities not exceed 0.08 in/sec. Correct equipment operating at vibration velocities that exceed this criteria.
   2. Seismic Restraint:
      a. Code and Standard Requirements:
         1) Seismic restraint of equipment, piping, and ductwork to be in accordance with latest enacted version of OSSC Chapter 16.
      b. Seismic Design Category:
         1) Confirm Seismic Design Category with Structural Engineer.
      c. Building Occupancy Category:
         1) Confirm Building Occupancy Category with Structural Engineer.
      d. Equipment Importance Factor: 1.0.
      e. Seismic restraint and anchorage of permanent equipment and associated systems listed below to building structure be designed to resist total design seismic force prescribed in local building code:
         1) Floor- or roof-mounted equipment weighing 400 pounds or greater.
         2) Suspended, wall-mounted or vibration isolated equipment weighing 20 pounds or greater.
         3) In-line duct devices connected to ductwork weighing 75 pounds or greater.
         4) Housekeeping slabs: provide reinforcement and anchorage to building structure.

f. Where required, seismic sway bracing of suspended duct and piping meet following:
   1) Pipe and duct runs requiring seismic bracing have minimum of two traverse braces and one longitudinal brace. Longitudinal (or traverse) brace at 90 degree change in direction may act as traverse (or longitudinal) brace if located within 2-feet of change in direction.
   2) Seismic bracing may not pass through seismic separation joint. Pipe or duct runs that pass through seismic separation joint must be restrained within 5-feet of both sides of separation.
   3) Seismic brace assembly spacing not to exceed 40-feet transverse and 80-feet longitudinal.

g. Seismic restraints may be omitted from suspended piping and duct if following conditions are satisfied:
   1) For piping or ducts supported by rod hangers 12-inches or less in length from top of duct to bottom of structural support. Top connections to structure have swivel joints, eye bolts, or vibration isolation hangers for entire length of system run.
   2) Lateral motion of system will not cause damaging impact with surrounding systems or cause loss of system vertical support.
   3) System must be welded steel pipe, brazed copper pipe, sheet metal duct or similar ductile material with ductile connections.

C. Seismic restraints, including anchors to building structure, be designed by registered professional Structural Engineer licensed in State of Oregon. Design includes:
   1. Number, size, capacity, and location of anchors for floor- or roof-mounted equipment. For curb-mounted equipment, provide design of attachment of both unit to curb and curb to structure.
   2. Number, size, capacity, and location of seismic restraint devices and anchors for vibration-isolation and suspended equipment. Provide calculations and test data verifying horizontal and vertical ratings of seismic restraint devices.
   3. Number, size, capacity, and location of braces and anchors for suspended piping and ductwork on as-built plan drawings.
   4. Maximum seismic loads to be indicated on drawings at each brace location. Drawings bear stamp and signature of registered professional Structural Engineer who designed layout of braces.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Seismic Snubber Units: Furnish replacement neoprene inserts for snubbers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Vibration Isolation:
   1. Amber/Booth
   2. B-Line Systems, Inc.
   3. Kinetics Noise Control, Inc.
   4. Mason Industries Inc.
   5. M.W. Sausse - Vibrex
   6. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
   7. Or approved equivalent.

B. Seismic Restraint Devices:
   1. Amber/Booth

2. B-Line Systems, Inc.
3. Hilti, Inc.
4. Kinetics Noise Control, Inc.
5. Mason Industries, Inc.
6. California Dynamics Corporation
7. Cooper B-Line Tolco.
8. Unistrut Diversified Products Co.; Wayne Manufacturing Division.
9. M.W. Sausse - Vibrex
10. Or approved equivalent.

C. Vibration Isolation Equipment Bases:
1. Amber/Booth
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. M.W. Sausse - Vibrex
5. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
6. Or approved equivalent.

D. Seismic-Bracing/Restraint Devices/Systems for Equipment, Piping and Ductwork:
1. Amber-Booth
2. California Dynamics Corporation
3. Cooper B-Line, Inc.
4. Hilti, Inc.
5. Mason Industries, Inc.
6. Kinetics Noise Control.
7. Unistrut
8. ISAT, Inc.
9. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
10. Or approved equivalent.

2.02 VIBRATION ISOLATION

A. Type 1 - Neoprene Pad: Natural rubber waffle pads, arranged in single or multiple layers, 3/4-inch thick per layer with pattern repeating on ½-inch centers; 50 durometer hardness; maximum loading 60 PSI. 1/4-inch thick steel load distribution plate between layers and between pad and equipment, factory cut to sizes matching requirements of supported equipment. Molded bridge with neoprene anchor bolt bushing and flat washer face to prevent metal to metal contact. Number of layers required for equipment scheduled. Mason Type: Super WMH.

B. Type 3 - Spring: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
2. Minimum Additional Travel: 50 percent of required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, natural rubber or bridge bearing neoprene isolator pad attached to baseplate underside. Baseplates limit floor load to 100 PSIG (690 kPa).
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
7. Brackets: Manufacturer's standard bracket, utilize height saving brackets to accommodate height restrictions.
8. Mason Type: SLFH.

C. Type 4a - Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
   1. Housing: Steel with resilient vertical-limit stops (out of contact during normal operation) to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, natural rubber or bridge bearing neoprene isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Restraining bolts have large rubber grommets to provide cushioning in vertical and horizontal directions. A minimum clearance of 3/8-inch maintained around restraining bolts so as not to interfere with spring action.
   2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
   3. Minimum Additional Travel: 50 percent of required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Brackets: Manufacturer's standard bracket, utilize height saving brackets to accommodate height restrictions.
   7. Mason Type: SLR.

D. Type 5b- Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
   1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 15 degrees of angular hanger-rod misalignment from vertical without binding or reducing isolation efficiency.
   2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
   3. Minimum Additional Travel: 50 percent of required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   7. Mason Type: 30N.

E. Type FC-1, Flexible duct connectors. See Specification Section 23 33 00 Air Duct Accessories.

F. Type FC-2A, Flexible Pipe Connector, Steel:
   1. 321 stainless steel, close pitch, annular corrugated hose.
   2. Exterior Sleeve: 304 stainless steel, braided.
   3. Pressure Rating: 125 PSI at 70 degrees F for 12-inch and smaller pipe.
   4. Joint: ANSI Class 150 carbon steel flanges.
   5. Size: Use pipe sized units.
   6. Minimum Allowable Offset: 3/4-inch on each side of installed center line.
   7. Basis of Design: Metraflex Model MLP.

G. Type FC-2B, Flexible Pipe Connector, Copper:
   1. Inner Hose: Bronze, close pitch, annular corrugated hose.
   2. Exterior Sleeve: Braided bronze (for piping over 2-inches, to be 3 pound braided stainless steel).
   3. Minimum Allowable Pressure Rating: 125 PSI at 70 degrees F.
   4. Joint: Sweat ends.
   5. Size: Use pipe sized units.
   6. Minimum Allowable Offset: 3/8-inch on each side of installed center line.
   7. Basis of Design: Metraflex Model BBS.

H. Type FC-2C, Flexible Pipe Connector, Gas:
   1. Inner Hose: 304 stainless steel.
   2. Exterior Sleeve: Braided, 304 stainless steel.

3. Minimum Allowable Pressure Rating: 150 PSI at 70 degrees F up to 4-inch pipe.
4. Joint: Threaded carbon steel.
5. Minimum Allowable Offset: 3/4-inch on each side of installed center line.
6. Basis of Design: Metraflex GASCT.

I. Type FC-3, Flexible Compensator, Double Sphere:
1. Body: Molded twin spherical type. Neoprene with internal cord or wire.
2. Minimum Pressure Rating, Sizes 2-inch to 12-inch: 225 PSI at 170 degrees F.
3. Minimum Pressure Rating, Sizes 14-inch to 20-inch: 125 PSI at 170 degrees F.
4. Minimum Allowable Compression: 1-1/2 inches.
5. Minimum Allowable Elongation: 1-1/8 inches.
6. Minimum Allowable Offset: 1-1/8 inches.
7. Minimum Allowable Angular Movement: 20 degrees.
8. Joint: Steel flanges.
9. Basis of Design: Metraflex Doublesphere.

2.03 SEISMIC RESTRAINT DEVICES

A. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.

B. Seismic Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings. Mason Type: Z-1011 or Z-1225. Snubber load rating to match equipment size.
1. Anchor bolts for attaching to concrete be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5.

C. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement. Mason Type: SCB.

D. Anchor Bolts: Seismic-rated, drill-in, and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M.

E. Seismic Restraint Systems for Ductwork and Piping:
1. Curb to have anchorage pre-approval “OPA” number from OSHPD in state of California attesting to maximum certified horizontal and vertical load ratings. Brace assemblies and rod clamps have an Anchorage Pre-approval "OPA" Number from OSHPD in State of California verifying maximum certified load ratings Fire/smoke dampers, fire dampers or any other device with break away connections cannot be used for seismic restraint.

2.04 VIBRATION ISOLATION EQUIPMENT BASES

A. Inertia Base (Type B-2): Factory-fabricated, welded structural -steel bases and rails ready for field applied, cast-in-place concrete. Mason Type: KSL, BMK.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.
5. Type 3, spring mounts. Mason Type: SLF.

6. Seismic Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings. Mason Type: Z-1011 or Z-1225. Snubber load rating to match equipment size.
    a. Anchor bolts for attaching to concrete be seismic-rated, drill-in, and stud-wedge or female-wedge type.
    b. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5.

2.05 FACTORY FINISHES

A. Provide manufacturer's standard prime-coat finish ready for field painting. Units mounted outdoors exposed to weather: Epoxy powder coated, with 1000 hour salt spray rating per ASTM B-117. For high levels of corrosion protection utilize:
    1. Kynar 500 Fluoropolymer Coating:
        a. Conform to AAMA 605.2.
        b. Apply coating following cleaning and pretreatment.
        c. Cleaning: AA-C12C42R1X.
        d. Dry system before final finish application.
        e. Total Dry Film Thickness: Approximately 1.2 mils, when baked at 450 degrees F for 10 minutes.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
    1. Powder coating on springs and housings.
    2. Hardware be electrogalvanized. Hot-dip galvanize metal components for exterior use.
    3. Baked enamel for metal components on isolators for interior use.
    4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

2.06 SEISMIC-BRACING/RESTRAINT DEVICES/SYSTEMS FOR EQUIPMENT, PIPING, AND DUCTWORK

A. General Requirements for Restraint Components: Rated strengths, features, and applications be as defined in reports by agency acceptable to authorities having jurisdiction.

B. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components be at least four times maximum seismic forces to which they will be subjected.

C. Anchor bolts for attaching to concrete to be seismic-rated, drill-in, and stud-wedge or female-wedge type.

D. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

E. Maximum 1/4-inch air gap, and minimum 1/4-inch thick resilient cushion.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:
    1. Vibration isolators and seismic restraint systems must be installed in strict accordance with manufacturer's written instructions and certified submittal data.
    2. Set floor-mounted equipment with steel base rails on 4-inch-high concrete housekeeping pads. Extend pad 6-inches beyond footprint of equipment in each direction.

3. Do not install equipment or pipe which makes rigid contact with building slabs, beams, studs, walls, etc.
4. Anchor baseplate to floor or structure. Provide rubber grommets and washers to isolate bolt from base plate. Under no circumstances is isolation efficiency to be destroyed when bolting isolators to floor.
5. Building Penetrations: Isolate water piping and ductwork penetrating wall, ceilings, floors or shafts from structure by piping isolator or by 3/8-inch thick foamed rubber insulation. Install units flush with finished structure face, using one for each side as required. Cut units to length if longer than structure thickness. Caulk around pipe or duct at equipment room wall.
6. Provide roof curbs, equipment supports, and roof penetrations. Work to maintain roof warranty. Coordinate location, size, structural connections/requirements and flashing prior to installation.
7. Vibration isolators must not cause change of position of equipment or piping which would stress piping connections or misalignment shafts or bearings. Isolated equipment is to be level and in proper alignment with connecting ducts and pipes.

3.03 VIBRATION ISOLATION EQUIPMENT INSTALLATION

A. Install isolation as indicated on drawings by type and location and where indicated below.

B. Equipment Vibration Isolation Schedule:

Equipment	Size	Vibration Isolator Type	Minimum Deflection (in)
Chillers: Screw or Scroll, Air-Cooled	All	Type 1, FC-3	1.5
Boilers	All	Type 1, FC-2	0.2
Base-Mounted Pumps	7.5+ HP	B-2, Type 1, FC-2	1.5
Fan-coils	All	Type 5B, FC-1,2	0.75
Condensing Units (Roof-Mounted)	All	Type 1	0.2
Condensing Units (Floor-Mounted)	All	Type 4A	2.5
Air Handlers	Up to 8,000 cfm	Type 1 (2-Layers), FC-1,2	0.75
Air Handlers	8,000 cfm or more	Type 1 (2-Layers) FC-1,2	
Axial, Cabinet, Centrifugal Inline Fans	0 to 23.5-inch diameter	Type 3, 4A, 5B, FC-1	0.75

C. Isolating Hangers:
1. Support piping and ductwork connected to isolated equipment within equipment rooms on isolating hangers as scheduled on drawings. Unless otherwise noted, first three hangers from isolated equipment to have a minimum of 1/2 static deflection of equipment isolators. Other isolating hangers to have a minimum of 1/4 static deflection of equipment isolators.
2. Position isolating hanger elements as high as possible in hanger rod assembly, but not in contact with building structure. Install hangers so that hanger housing may rotate full 360 degrees about rod axis without contacting any object.
3. Unless otherwise noted, air supply units with internally isolated fans do not require isolating hangers for connecting pipes and ductwork.
4. Where parallel running pipes are hung together on an isolated trapeze, provide isolator deflections for largest determined by provisions for pipe isolation. Do not mix isolated and non-isolated pipes in same trapeze.
5. Install limit stops so they are out of contact during normal operation.

D. Equipment Bases:

1. Fill concrete inertia bases, after installing base frame, with 3000-PSI (20.7-MPa) concrete; trowel to a smooth finish.
2. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for seismic codes at Project site.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.04 SEISMIC RESTRAINTS

A. General:
1. Install and adjust seismic restraints so that equipment, piping, and ductwork supports are not degraded by restraints.
2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.
3. Install restraining cables at each trapeze, individual pipe hanger and hanging vibration isolated equipment. Provide restraining cables in each of the four directions of movement. Install restraining cables no less than 45 Degrees from vertical. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.
4. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

3.05 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

E. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.06 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION

SECTION 23 0553

IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Plastic Nameplates
   2. Tags
   3. Plastic Pipe Markers
   4. Plastic Duct Markers
   5. Ceiling Tags

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Schedules:
      a. Submit valve schedule for each piping system, in tabular format using Microsoft Word or Excel software. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
   2. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23, HVAC Sections. Where more than a single type is specified for application, provide single selection for each product category.

B. Plastic Nameplates:
   1. Brady Corporation
   2. Brimar
   3. Champion America
   4. Craftmark
   5. Seton

6. Or approved equivalent.

C. Tags:
1. Brady Corporation
2. Brimar
3. Champion America
4. Craftmark
5. Seton
6. Or approved equivalent.

D. Plastic Pipe Markers:
1. Brady Corporation
2. Brimar
3. Champion America
4. Craftmark
5. Seton
6. Or approved equivalent.

E. Plastic Duct Markers:
1. Brady Corporation
2. Brimar
3. Champion America
4. Craftmark
5. Seton
6. Or approved equivalent.

F. Ceiling Tags:
1. Brady Corporation
2. Brimar
3. Champion America
4. Craftmark
5. Seton
6. Or approved equivalent.

2.02 PLASTIC NAMEPLATES

A. Description: Engraving stock melamine plastic laminate in the size and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color), punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Provide 1/8-inch thick material.
1. Letter Color: White.
2. Letter Height: 1/2-inch.
3. Background Color: Black.
4. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
5. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or devices/equipment. Include center hole to allow attachment.

2.03 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 2-inch diameter.

B. Metal Tags: Polished Brass with stamped letters; tag size minimum 2-inch diameter with smooth edges.

C. Valve Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks.

D. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7-inches.

2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
4. Color: Yellow background with black lettering.

2.04 PLASTIC PIPE MARKERS

A. Color: Conform to ASME A13.1 and ANSI Z535.1.

B. Plastic Pipe Markers (for external diameters of 6-inches and larger including insulation): Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Plastic Tape Pipe Markers (for external diameters less than 6-inches including insulation): Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Lettering:
1. 3/4-inch to 1-1/4-inch Outside Diameter of Insulation or Pipe: 8-inch long color field, 1/2-inch high letters.
2. 1-1/2-inch to 2-inch Outside Diameter of Insulation or Pipe: 8-inch long color field, 3/4-inch high letters.
3. 2-1/2-inch to 6-inch Outside Diameter of Insulation or Pipe: 12-inch long color field, 1-1/4-inch high letters.
4. 8-inch to 10-inch Outside Diameter of Insulation or Pipe: 24-inch long color field, 2-1/2-inch high letters.
5. Over 10-inch Outside Diameter of Insulation or Pipe: 32-inch long color field, 3-1/2-inch high letters.

2.05 PLASTIC DUCT MARKERS

A. General: Manufacturer's standard laminated plastic, color-coded duct markers. Supply separate color codes for supply, exhaust, outside, return air and hazardous exhaust lab, chemical, fume hood, isolation room systems.

B. Include the Following Nomenclature:
1. Direction of air flow.
2. Duct service (supply, return, general exhaust, outdoor air), kitchen exhaust, dishwasher exhaust, fume hood exhaust, isolation room exhaust, etc.).

2.06 CEILING TAGS

A. Description: Steel with 3/4-inch diameter color coded head.

B. Color code as follows:
1. Yellow - HVAC equipment.
2. Red - Fire dampers/smoke dampers.
3. Blue - Heating/cooling valves.
4. Ceiling tile labels, machine generated, adhesive backed tape labels with black letters, clear tape.

PART 3 - EXECUTION

3.01 GENERAL - INSTALLATION

A. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates riveted to equipment body.

B. Identify ductwork with plastic ductmarkers.

C. Identify piping, concealed or exposed, with plastic pipe markers.

D. Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

E. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Chiller No. 3, Air Handling Unit No. 42, Standpipe F12, and the like).

F. Degrease and clean surfaces to receive adhesive for identification materials.

G. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

H. Install all products in accordance with manufacturer's instructions.

I. Manual Balancing Dampers: Provide 12-inch long orange marker ribbon to end of balancing damper handle.

3.02 PLASTIC NAMEPLATES

A. Install plastic nameplates with corrosive-resistant mechanical fasteners.

B. Identify control panels and major control components outside panels with plastic nameplates riveted to equipment body.

C. Identify thermostats with nameplates.

3.03 TAGS

A. Use metal tags on piping 3/4-inch diameter and smaller.

B. Tag balancing valves and major dampers with balanced GPM or CFM indicated after balancing is completed and accepted.

C. Install tags with corrosion resistant chain.

D. Small devices, such as in-line pumps, may be identified with tags.

E. Identify valves in main and branch piping with metal tags. Indicate valve function and the normally open or closed positions on the valve tag.

F. Identify air terminal units and radiator valves with numbered plastic tags.

G. Tag automatic controls, instruments, and relays. Key to control schematic.

H. Install valve schedule at each mechanical room.

3.04 PLASTIC PIPE MARKERS

A. Install plastic pipe markers complete around pipe in accordance with manufacturer's instructions.

B. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20-feet (reduced to 10-feet in congested areas and mechanical equipment rooms) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction. Locate near branches, valves, control devices, equipment connections, access doors, floor/wall penetrations.

3.05 PLASTIC DUCT MARKERS

A. Identify air supply, return, exhaust, isolation room exhaust, and outside air intake ductwork with duct markers, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork identification color). Identify with air handling unit identification number and area served. Locate identification at air handling unit, in mechanical rooms, at each side of penetration of structure or enclosure, at each obstruction, and within view of access doors/panels. In each space where ductwork is exposed, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment) and at 50 foot spacing along exposed runs. Where noted on Drawings, identify ductwork in exposed/public locations.

B. Access Doors: Provide duct markers on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions.

3.06 CEILING TAGS

A. Provide ceiling tile labels to identify valves, dampers, and equipment above accessible ceilings.

B. Provide ceiling tags to locate valves, dampers, and equipment above accessible ceilings. Locate in corner of ceiling tee grid closest to equipment.

END OF SECTION

SECTION 23 0593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. General Requirements and Procedures
   2. Ductwork Pressure Testing
   3. Fundamental Air Systems Balancing Procedures
   4. Constant Volume Air Systems Balancing Procedures
   5. Variable Air Volume Systems Additional Procedures
   6. Kitchen and Dishwasher Hoods
   7. Fundamental Procedures for Hydronic Systems
   8. Pump Balancing Procedures
   9. Variable Flow Hydronic Systems Additional Procedures
   10. Final Reports:
      a. Report Requirements
      b. General Report Data
      c. Air Handling Units
      d. Hydronic Coils
      e. Fans
      f. Duct Traverses
      g. Diffusers/Registers/Grilles
      h. Chillers
      i. Pumps
      j. Boilers
      k. Instrument Calibration
   11. Additional Tests

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Quality-Assurance Submittals: Submit two copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
   2. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit two copies of the Contract Documents review report as specified in Part 3 of this Section.
   3. Strategies and Procedures Plan: Submit two copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 below. Include a complete set of report forms intended for use on this Project.
   4. Specify reports required because of editing procedures in Part 3 of this Section.
   5. Certified Testing, Adjusting, and Balancing Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
   6. Sample Report Forms: Submit two sets of sample testing, adjusting, and balancing report forms.

7. Test Instrument Calibration: Submit proof of calibration within the last 6 months.
8. Final Report.
9. Provide additional submittals to commissioning authority as dictated in commissioning specifications.

1.05 QUALITY ASSURANCE

A. Quality Assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Acceptable Balance Firm:
      a. General:
         1) Procure services of independent balance and testing agency which specializes in balancing and testing of plumbing, heating, ventilating, and air conditioning systems, to balance, adjust and test water circulating and air moving equipment and air distribution or exhaust systems. Minimum Experience: 5 years.
      b. Industry Standards: Testing and Balancing will conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
         1) NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
         2) ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
         3) ANSI:
            (a) S1.4 Specifications for sound level meters.
            (b) S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.
            (c) ANSI S1.13 Methods for the Measurement of Sound Pressure Levels.
      c. Test Observation: If requested, conduct tests in the presence of the Architect or the Architect's representative.
   2. Provide proof of testing agency having successfully completed at least five projects of similar size and scope.
   3. Code Compliance: Perform tests in the presence of the Authority Having Jurisdiction (AHJ) where required by the Authority Having Jurisdiction (AHJ).
   4. Owner Witness: Perform tests in the presence of the Owners representative.
   5. Engineer Witness: The engineer or engineer's representative reserves the right to observe tests or selected tests to assure compliance with the specifications.
   6. Simultaneous Testing: Test observations by the Authority Having Jurisdiction (AHJ), the Owner's representative and the engineer's representative need not occur simultaneously.
   7. Do not perform testing, adjusting, and balancing work until heating, ventilating, and air conditioning equipment has been completely installed and is operating continuously as required.
   8. Conduct air testing and balancing with clean filters in place. Clean strainers prior to performing hydronic testing and balancing.
   9. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by AABC or NEBB.
   10. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days advance notice of scheduled meeting time and location.
      a. Agenda Items: Include at least the following:
         1) Submittal distribution requirements.
         2) Contract Documents examination report.
         3) Testing, adjusting, and balancing plan.

4) Work schedule and Project site access requirements.
5) Coordination and cooperation of trades and subcontractors.
6) Coordination of documentation and communication flow.

11. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
    a. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
    b. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
12. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing."
13. Testing, Adjusting, and Balancing Reports: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
14. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.
15. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
16. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
    1. TAB Agency provides warranty for a period of 90 days following submission of completed report, during which time, Owner may request a recheck of up to 10 percent of total number of terminals, or resetting of any outlet, coil, or device listed in the final TAB report.
    2. Guarantee: Meet the requirements of the following programs:
        a. Provide a guarantee on AABC or NEBB forms stating that the agency will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:
            1) The certified Agent has tested and balanced systems according to the Contract Documents.
            2) Systems are balanced to optimum performance capabilities within design and installation limits.

1.07 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a persons skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

J. TAB: Testing and Balancing.

K. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

L. Test: A procedure to determine quantitative performance of a system or equipment.

M. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

N. AABC: Associated Air Balance Council.

O. AMCA: Air Movement and Control Association.

P. NEBB: National Environmental Balancing Bureau.

Q. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.08 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS AND PROCEDURES

A. Project Conditions:
   1. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.
   2. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

B. General Requirements:
   1. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and controls, coordinate scheduling and testing and inspection procedures with authorities having jurisdiction.
   2. Perform TAB work with doors, closed windows, and ceilings installed etc., to obtain simulated or project operating conditions. Do not proceed until systems scheduled for testing, adjusting and balancing are clean and free from debris, dirt and discarded building materials.
   3. Where Owner occupies building during the testing period, cooperate with Owner to minimize conflicts with Owner's operations.

C. Examination:
   1. Examine Contract Documents to become familiar with project requirements and existing building record documents (if available) to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
      a. Contract Documents are defined in the General and Supplementary Conditions of the Contract.

b. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

2. Examine approved submittal data of HVAC systems and equipment.
3. Examine project record documents described in Division 01, General Requirements.
4. Examine Architect's and Engineer's design data, including Basis of Design, HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
5. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when equipment is installed under conditions different from those designed and equipment is not is not performing as designed. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
6. Coordinate requirements in system and equipment with this Section.
7. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
8. Examine system and equipment test reports.
9. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
10. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
11. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.
12. Beginning of work means acceptance of existing conditions.

D. Preparation:
1. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.
2. Complete system readiness checks and prepare system readiness reports. Verify the following:
   a. Permanent electrical power wiring is complete.
   b. Hydronic systems are filled, clean, and free of air.
   c. Automatic temperature-control systems are operational.
   d. Equipment and duct access doors are securely closed.
   e. Balance, smoke, and fire dampers are open.
   f. Isolating and balancing valves are open and control valves are operational.
   g. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   h. Windows, doors and other portions of the building envelope can be closed so design conditions for system operations can be met.
3. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   a. Attendance is required by installers whose work will be tested, adjusted, or balanced.
4. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

E. General Testing and Balancing Procedures:

1. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
2. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
3. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

F. Adjustment Tolerances:
1. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
2. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
3. Hydronic Systems: Adjust to within plus or minus 10 percent of design at coils and plus or minus 5 percent at system pumps and equipment.
4. Adjust supply, return, and exhaust air quantities to maintain pressurization in spaces indicated on Drawings. Note and document room-to-room pressurization and maintain these relationships. Adjust pressure controlled spaces to within plus or minus 0.01 in WC.

G. Recording and Adjusting:
1. Ensure recorded data represents actual measured or observed conditions.
2. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
3. Mark on drawings locations where traverse and other critical measurements were taken and cross reference location in final report.
4. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
5. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
6. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner's Representative, or Commissioning Agent.

3.02 DUCTWORK PRESSURE TESTING

A. Provide air pressure testing of concealed ductwork systems (testing is not required for ductwork exposed to air conditioned space) downstream of AHU-ADMIN supply fan and upstream of each terminal unit. Pressure test entire supply system at one time. Test ductwork prior to connection to fan equipment. Repair leaks and retest until stipulated results are achieved.

B. Test ductwork prior to connection to fan equipment. Repair leaks and retest until stipulated results are achieved. Pressure testing to meet the following leakage classifications below as a minimum (ASHRAE Chapter 35, Table 6):
1. Leakage class to be as defined below as a minimum.
a. Minimum Duct Leakage Classification

Duct Type	**Leakage Class**
Metal (Flexible excluded)	
Round and flat oval	3
Rectangular	
Less than or equal to 2-inches of water (both positive and negative pressures)	12
Greater than 2 and less than or equal to 10-inches of water (both positive and negative pressures)	6

2. Testing machine: Meet requirements of SMACNA standards. Pacific Air Products "Port-O-Lab", Rolok, or United Sheet Metal
3. Test supply systems prior to connecting terminal units.
4. Perform tests in presence of Owner's Representative. Give 48 hours advance notice before commencement of each test.
5. Test ductwork systems in Sections as large as possible and record test results accordingly.
6. Coordinate testing with ceiling installation.
    a. Provide sheet-metal plates and install between each duct test Section (applies to main-to-main fittings, branch-to-branch fittings and main-to-branch fittings). At each plate location, fabricate joint with Ductmate. Insert 14 gauge sheet metal between Ductmate using a neoprene gasket on both sides of metal plate.
    b. Leave plates in place until isolated Section has been tested and approved by Owner's Representative.
    c. Once Sections have passed test, remove plates and reattach Ductmate joints. After fan unit is running, test joint for leakage by using a mixture of soap and water. If any noise or bubbling occurs, reseal joint. Owner's representative to witness this procedure.
7. Test duct at 1.5 times the design air pressure. Seal any audible leaks.

3.03 FUNDAMENTAL AIR SYSTEMS BALANCING PROCEDURES

A. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

B. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.

C. Examine plenum ceilings, utilized for supply air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

D. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

E. Prepare test reports for both fans and inlets and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan volumes.

F. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

G. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

H. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

I. Verify that motor starters are equipped with thermal protection, sized for the connected load.

J. Check dampers for proper position to achieve desired airflow path.

K. Check for airflow blockages.

L. Check that condensate drains are installed, trapped and primed and routed to drain.

M. Check for readily observable leaks in air-handling unit components and ductwork.

N. Use sheaves and pulleys to adjust the speed of belt drive fans to achieve design flow iwth motors running at 60 Hertz unless noted otherwise.

3.04 CONSTANT-VOLUME AIR SYSTEMS BALANCING PROCEDURES

A. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer. Adjust fans to deliver design airflow at the lowest possible speed.
    1. Measure fan static pressures to determine actual static pressure as follows:
        a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
        b. Measure static pressure directly at the fan outlet or through the flexible connection.

c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each air-handling unit component under final balanced condition.
3. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Recommend corrective action to align design and actual conditions.
4. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
5. Do not make fan-speed adjustments that result in motor loading greater than full load amps. Do not increase fan speed beyond fan class rating. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.
6. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.
7. Calibrate airflow measuring stations.

3.05 VARIABLE-AIR-VOLUME SYSTEMS ADDITIONAL PROCEDURES

A. Compensating for Diversity:
1. When the total airflow of terminal units is more than the fan design airflow volume, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the design airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
2. Pressure-Independent, Variable-Air-Volume Systems:
a. After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1) Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2) Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure to deliver design airflow at the terminal unit.
3) Measure total system airflow. Adjust to within 10 percent of design airflow.
4) Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use the terminal unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5) Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
(a) If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
6) Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7) Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure adequate static pressure is maintained at the most critical unit. Balance system to achieve the lowest required differential pressure for the system to minimize fan brake horsepower.
8) Balance terminal units in variable volume systems for maximum cooling, maximum heating, and minimum ventilation (demand based ventilation systems) airflow rates.

9) Record the final fan performance data.

3. Additional Requirements: Provide all additional procedures to compensate for diversity as prescribed in ASHRAE and/or NEBB standards.
4. Calibrate airflow measuring stations.

3.06 KITCHEN AND DISHWASHER HOODS

A. Determine total airflow into the room where the hood is located and balance systems to ensure adequate air supply to hoods.
   1. Energize the exhaust fan and adjust airflow to provide the indicated hood exhaust air flow rate.
   2. Measure exhaust airflow volume by measuring airflow by Pitot-tube duct traverse.
   3. Record each face velocity measurement taken at 4- to 6-inch increments over the entire hood opening.
   4. Calculate the average face velocity by averaging velocity measurements.
   5. Calculate the airflow volume of exhaust-hood face velocity by multiplying the calculated face velocity by the opening area. Compare this quantity with exhaust volume at exhaust fan and report duct leakage.
   6. Measure airflow volume supplied by makeup fan. Verify that the makeup system supplies the proper amount of air to keep the space at the indicated pressure with the exhaust systems in all operating conditions.
   7. Retest for average face velocity. Adjust hood baffles, fan drives, and other parts of the system to provide the indicated average face velocity and the indicated auxiliary air-supply percentages.
   8. Retest and adjust the systems until fume-hood performance complies with Contract Documents.
   9. For variable volume systems, conduct tests above at full flow conditions, in addition test over entire range of variable flow in 10 percent increments. Test in accordance with variable flow control system manufacturer's recommended test procedures.

3.07 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Examine strainers for clean screens and proper perforations.

B. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

C. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.

D. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

E. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
   1. Open manual valves for maximum flow.
   2. Check expansion tank liquid level, or air charge if bladder type.
   3. Check makeup-water-station pressure gauge for adequate pressure for highest vent.
   4. Check flow-control valves for specified sequence of operation and set at design flow.
   5. Set differential-pressure control valves at the specified differential pressure.
   6. Set system controls so automatic valves are wide open to heat exchangers and coils.
   7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
   8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

F. Calibrate waterflow measuring stations.

3.08 PUMP BALANCING PROCEDURES

A. Determine water flow at pumps. Use the following procedures:
   1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in

gauge heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.

2. Check system resistance. With valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved. Report flow rates that are not within plus or minus 5 percent of design.
3. Verify pump-motor amperage. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Set calibrated balancing valves, if installed, at calculated presettings.
5. Measure flow at stations and adjust, where necessary, to obtain first balance. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
6. Measure flow at main balancing station and set main balancing device or adjust pump speed to achieve flow that is 5 percent greater than design flow.
7. Adjust balancing stations to within specified tolerances of design flow rate as follows:
   a. Determine the balancing station with the highest percentage over design flow.
   b. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
   c. Record settings and mark balancing devices.
8. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.
9. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.09 VARIABLE FLOW HYDRONIC SYSTEMS ADDITIONAL PROCEDURES

A. Balance hydronic system for two different operating points. Provide differential pressure setpoints to controls installer to provide full heating water and cooling water flow as listed in schedules of air handing units, fan coils, and duct-mounted coils.

B. Balance system to achieve the lowest required differential pressure for the system to minimize pump brake horsepower.

3.10 FINAL REPORTS

A. Report Requirements:
   1. General:
      a. Computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into Sections by tested and balanced systems.
      b. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
         1) Include a list of the instruments used for procedures, along with proof of calibration.
      c. Final Report Contents: In addition to the certified field report data, include the following:
         1) Pump curves.
         2) Fan Curves
         3) Manufacturers Test Data
         4) Field test reports prepared by system and equipment installers.
         5) Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

B. General Report Data:
   1. In addition to the form titles and entries, include the following data in the final report, as applicable:
      a. Title Page
      b. Name and Address of Testing, Adjusting, and Balancing Agent
      c. Project Name

d. Project Location
e. Architect's Name and Address
f. Engineer's Name and Address
g. Contractor's Name and Address
h. Report Date
i. Signature of Testing, Adjusting, and Balancing Agent who Certifies the Report
j. Summary of Contents, Including the Following:
    1) Design versus Final Performance
    2) Notable Characteristics of Systems
    3) Description of System Operation Sequence if it varies from the Contract Documents
k. Nomenclature Sheets for Each Item of Equipment
l. Data for Terminal Units, including Manufacturer, Type Size, and Fittings
m. Notes to explain why certain final data in the body of reports vary from design values.
n. Test Conditions for Fans and Pump Performance Forms, Including the Following:
    1) Settings for Outside-, Return-, and Exhaust-air Dampers
    2) Conditions of Filters
    3) Cooling Coil, Wet- and Dry-bulb Conditions
    4) Face and Bypass Damper Settings at Coils
    5) Fan Drive Settings, including Settings and Percentage of Maximum Pitch Diameter
    6) Inlet Vane Settings for Variable-Air-Volume Systems
    7) Settings for Supply-air, Static-pressure Controller
    8) Other System Operating Conditions that affect Performance

C. Air Handling Units:
1. For air-handling units, packaged rooftop unit air handlers, split systems, fan coils, heat pumps, and evaporator units with coils, include the following:
    a. Unit Data: Include the following:
        1) Unit Identification
        2) Location
        3) Make and Type
        4) Model Number and Unit Size
        5) Manufacturer's Serial Number
        6) Unit Arrangement and Class
        7) Discharge Arrangement
        8) Sheave Make, Size in inches, and Bore
        9) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches
        10) Number of Belts, Make, and Size
        11) Number of Filters, Type, and Size
    b. Motor Data: Include the following:
        1) Make and Frame Type and Size
        2) Horsepower and rpm
        3) Volts, Phase, and Hertz
        4) Full-load Amperage and Service Factor
        5) Sheave Make, Size in Inches, and Bore
        6) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches
    c. Test Data: Include design and actual values for the following:
        1) Total Airflow Rate in cfm (L/s)
        2) Total System Static Pressure in Inches wg (Pa)
        3) Fan rpm
        4) Discharge Static Pressure in Inches wg (Pa)
        5) Filter Static-pressure Differential in Inches wg (Pa)
        6) Preheat Coil Static-pressure Differential in Inches wg (Pa)
        7) Cooling Coil Static-pressure Differential in Inches wg (Pa)

8) Heating Coil Static-pressure Differential in Inches wg (Pa)
9) Outside Airflow in cfm (L/s)
10) Return Airflow in cfm (L/s)
11) Outside-air Damper Position
12) Return-air Damper Position
13) Vortex Damper Position

D. Hydronic Coils:
1. For hydronic coils in all equipment with coils, include the following:
a. Coil Data: Include the following:
1) System Identification
2) Location and Zone
3) Room or Riser Served
4) Coil Type
5) Number of Rows
6) Fin Spacing in Fins per Inch o.c.
7) Make and Model Number
8) Face Area in SF
9) Tube Size in NPS (DN)
10) Tube and fin Materials
11) Circuiting Arrangement
b. Test Data: Include design and actual values for the following:
1) Airflow Rate in cfm
2) Average Face Velocity in fpm
3) Air Pressure Drop in Inches wg
4) Outside-air, Wet- and Dry-bulb Temperatures in Degrees F
5) Return-air, Wet- and Dry-bulb Temperatures in Degrees F
6) Entering-air, Wet- and Dry-bulb Temperatures in Degrees F
7) Leaving-air, Wet- and Dry-bulb Temperatures in Degrees F
8) Water Flow Rate in gpm
9) Water Pressure Differential in Feet of Head or PSIG
10) Entering-water Temperature in Degrees F
11) Leaving-water Temperature in Degrees F

E. Fans:
1. Fan Test Reports: For supply, return, and exhaust fans, include the following:
a. Fan Data: Include the following:
1) System Identification
2) Location
3) Make and Type
4) Model Number and Size
5) Manufacturer's Serial Number
6) Arrangement and Class
7) Sheave Make, Size in Inches, and Bore
8) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches.
b. Motor Data: Include the following:
1) Make and Frame Type and Size
2) Horsepower and rpm
3) Volts, Phase, and Hertz
4) Full-load Amperage and Service Factor
5) Sheave Make, Size in Inches, and Bore
6) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches
7) Number of Belts, Make, and Size
c. Test Data: Include design and actual values for the following:
1) Total Airflow Rate in cfm

2) Total System Static Pressure in Inches wg
3) Fan rpm
4) Discharge Static Pressure in Inches wg
5) Suction Static Pressure in Inches wg

F. Duct Traverses:
1. Include a diagram with a grid representing the duct cross-Section and record the following:
a. Report Data: Include the following:
1) System and Air-handling Unit Number
2) Location and Zone
3) Traverse Air Temperature in Degrees F
4) Duct Static Pressure in Inches wg
5) Duct Size in Inches
6) Duct Area in SF
7) Design Airflow Rate in cfm
8) Design Velocity in fpm
9) Actual Airflow Rate in cfm
10) Actual Average Velocity in fpm
11) Barometric Pressure in PSIG

G. Diffusers/Registers/Grilles:
1. For diffusers, registers and grilles, include the following:
a. Unit Data: Include the following:
1) System and Air-handling Unit Identification
2) Location and Zone
3) Test Apparatus Used
4) Area Served
5) Air-terminal-device Make
6) Air-terminal-device Number from System Diagram
7) Air-terminal-device Type and Model Number
8) Air-terminal-device Size
9) Air-terminal-device Effective Area in SF
b. Test Data: Include design and actual values for the following:
1) Airflow Rate in cfm
2) Air Velocity in fpm
3) Preliminary Airflow Rate as Needed in cfm
4) Preliminary Velocity as Needed in fpm
5) Final Airflow Rate in cfm
6) Final Velocity in fpm
7) Space Temperature in Degrees F

H. Chillers:
1. For each chiller, include the following:
a. Unit Data: Include the following:
1) Unit Identification
2) Make and Model Number
3) Manufacturer's Serial Number
4) Refrigerant Type and Capacity in Gallons
5) Starter Type and Size
6) Starter Thermal Protection Size
b. Condenser Test Data: Include design and actual values for the following:
1) Refrigerant Pressure in PSIG
2) Refrigerant Temperature in Degrees F
3) Entering-water Temperature in Degrees F
4) Leaving-water Temperature in Degrees F
5) Entering-water Pressure in Feet of Head or PSIG

6) Water Pressure Differential in Feet of Head or PSIG

c. Evaporator Test Reports: Include design and actual values for the following:
1) Refrigerant Pressure in PSIG
2) Refrigerant Temperature in Degrees F
3) Entering-water Temperature in Degrees F
4) Leaving-water Temperature in Degrees F
5) Entering-water Pressure in Feet of Head or PSIG
6) Water Pressure Differential in Feet of Head or PSIG

d. Compressor Test Data: Include design and actual values for the following:
1) Make and Model Number
2) Manufacturer's Serial Number
3) Suction Pressure in PSIG
4) Suction Temperature in Degrees F
5) Discharge Pressure in PSIG
6) Discharge Temperature in Degrees F
7) Oil Pressure in PSIG
8) Oil Temperature in Degrees F
9) Voltage at Each Connection
10) Amperage for Each Phase
11) The kW Input
12) Crankcase Heater kW
13) Chilled Water Control Set Point in Degrees F
14) Refrigerant Low-pressure-cutoff Set Point in PSIG
15) Refrigerant High-pressure-cutoff Set Point in PSIG

e. Refrigerant Test Data: Include design and actual values for the following:
1) Oil Level
2) Refrigerant Level
3) Relief Valve Setting in PSIG
4) Unloader Set Points in PSIG
5) Bearing Temperatures in Degrees F
6) Low-temperature-cutoff Set Point in Degrees F

I. Pumps:
1. For pumps, include the following data. Calculate impeller size by plotting the shutoff head on pump curves.
a. Unit Data: Include the following:
1) Unit Identification
2) Location
3) Service
4) Make and Size
5) Model and Serial Numbers
6) Water Flow Rate in gpm
7) Water Pressure Differential in Feet of Head or PSIG
8) Required Net Positive Suction Head in Feet of Head or PSIG
9) Pump rpm
10) Impeller Diameter in Inches
11) Motor Make and Frame Size
12) Motor Horsepower and rpm
13) Voltage at Each Connection
14) Amperage for Each Phase
15) Full-load Amperage and Service Factor
16) Seal Type

b. Test Data: Include design and actual values for the following:
1) Static Head in Feet of Head or PSIG
2) Pump Shutoff Pressure in Feet of Head or PSIG

3) Actual Iimpeller Size in Inches
4) Full-open Flow Rate in gpm
5) Full-open Pressure in Feet of Head or PSIG
6) Final Discharge Pressure in Feet of Head or PSIG
7) Final Suction Pressure in Feet of Head or PSIG
8) Final Total Pressure in Feet of Head or PSIG
9) Final Water Flow Rate in gpm
10) Voltage at Each Connection
11) Amperage for Each Phase

J. Boilers:
1. For boilers, include the following:
a. Unit Data: Include the following:
1) Unit Identification
2) Location
3) Service
4) Make and Type
5) Model and Serial Numbers
6) Fuel Type and Input in Btuh
7) Number of Passes
8) Ignition Type
9) Burner-control Types
10) Voltage at Each Connection
11) Amperage for Each Phase
12) Flue-gas Analysis
b. Test Data: Include design and actual values for the following:
1) Operating Pressure in PSIG
2) Operating Temperature in Degrees F
3) Entering-water Temperature in Degrees F
4) Leaving-water Temperature in Degrees F
5) Number of Safety Valves and Sizes in NPS (DN)
6) Safety Valve Settings in PSIG
7) High-limit Setting in PSIG
8) Operating-control Setting
9) High-fire Set Point
10) Low-fire Set Point
11) Voltage at Each Connection
12) Amperage for Each Phase
13) Draft Fan Voltage at Each Connection
14) Draft Fan Amperage for Each Phase
15) Manifold Pressure in PSIG

K. Instrument Calibration:
1. For instrument calibration, include the following:
a. Report Data: Include the following:
1) Instrument Type and Make
2) Serial Number
3) Application.
4) Dates of Use
b. Dates of Calibration.

3.11 ADDITIONAL TESTS

A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 0700
HVAC INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Type A, Flexible Fiberglass Blanket
   2. Type B, Duct Liner
   3. Type E, Fire Protection Duct Wrap
   4. Type 1, Fiberglass Pipe Insulation
   5. Type 2, Flexible Elastomeric Insulation
   6. Jacketing
   7. Accessories
   8. Duct Insulation Accessories
   9. Duct Insulation Compounds

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Piping and duct insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Installer qualifications.
   2. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any) for each type of product indicated.
   3. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.
   4. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.
   5. Submit manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Installer to have minimum 5 years experience in the business of installing insulation.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 FIRE HAZARD CLASSIFICATION

A. Maximum fire hazard classification of the composite insulation construction as installed to be not more than a flame spread of 25, fuel contributed of 50 and smoke developed of 50 as tested by current edition of ASTM E84 (NFPA 255) method.

B. Test pipe insulation in accordance with the requirements of current edition of UL "Pipe and Equipment Coverings R5583 400 8.15."

C. Test duct insulation in accordance with current edition of ASTM E84, UL 723, NFPA 255, NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Type A, Flexible Fiberglass Blanket:
   1. Certainteed
   2. Johns Manville
   3. Knauf
   4. Owens-Corning
   5. PPG
   6. Or approved equivalent.

B. Type B, Duct Liner:
   1. Certainteed
   2. Johns Manville
   3. Knauf
   4. Owens-Corning
   5. PPG
   6. Or approved equivalent.

C. Type E, Fire Protection Duct Wrap:
   1. Firemaster
   2. Unifrax
   3. 3M
   4. Or approved equivalent.

D. Type 1, Fiberglass Pipe Insulation:
   1. Certainteed
   2. Johns Manville
   3. Knauf
   4. Owens-Corning
   5. PPG
   6. Or approved equivalent.

E. Type 2, Flexible Elastomeric Insulation:
   1. Armacell LLC Armaflex.
   2. Or approved equivalent.

2.02 TYPE A, FLEXIBLE FIBERGLASS BLANKET

A. ASTM C553, Type 1, Class B-2; flexible blanket.

B. 'K' Value: 0.27 BTU*in/(hr*sf*F) at 75 degrees F installed, maximum service temperature: 250 degrees F.

C. Density: 0.75 pounds per cubic foot.

D. Vapor Barrier Jacket: FSK aluminum foil reinforced with fiberglass yarn and laminated to fire resistant Kraft, secured with UL listed pressure sensitive tape or outward clinched expanded staples and vapor barrier mastic as needed.

2.03 TYPE B, DUCT LINER

A. ASTM C1071; flexible blanket.

B. 'K' Value: ASTM C518, 0.25 BTU*in/(hr*sf*F) at 75 degrees F, maximum service temperature: 250 degrees F.

C. Noise Reduction Coefficient: 0.65 or higher based on "Type A mounting."

D. Maximum Velocity on Mat or Coated Air Side: 5,000 FPM.

E. Adhesive: UL listed waterproof type.

F. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

G. Erosion-Resistant Surfaces: UL 181.

H. ASTM G21 and ASTM G22 Microbial Growth Resistance.

2.04 TYPE E, FIRE PROTECTION DUCT WRAP

A. Firemaster: Thermal Ceramics "Firemaster" duct wrap ceramic fiber blanket, minimum 3-inch thickness, ASTM E119, 2-hour rated assembly.

B. Fyrewrap: Unifrax "Fyrewrap" duct wrap glass fiber blanket, 1.5-inch thickness for 1-hour rated assembly, 3-inch thickness for 2-hour rated assembly. ASTM E-1119.

C. Grease Ducts not enclosed in rated shaft: 3M Fire Barrier duct wrap 615+, compliant with UL1978, AC101 and ASTM 2336, foil encapsulated.

2.05 TYPE 1, FIBERGLASS PIPE INSULATION

A. Glass Fiber: ASTM C547; rigid molded, noncombustible.
   1. Thermal Conductivity Value: As indicated in the insulation tables below.
   2. Maximum Service Temperature: 850 degrees F.
   3. Vapor Retarder Jacket: White Kraft paper reinforced with glass fiber and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or vapor barrier mastic.

2.06 TYPE 2, FLEXIBLE ELASTOMERIC INSULATION

A. Elastomeric Foam: ASTM C534; flexible, cellular elastomeric, molded or sheet.
   1. Thermal Conductivity Value: As indicated in the insulation tables below.
   2. Maximum Service Temperature of 220 degrees F.
   3. Maximum Flame Spread: 25.
   4. Maximum Smoke Developed: 50 (1-inch thick and below).
   5. Connection: Waterproof vapor retarder adhesive as needed.
   6. UV Protection: UV outdoor protective coating per manufacturers requirements.

B. Glue: Contact adhesive specifically manufactured for cementing flexible elastomeric foam. Armacell LLC Armaflex Low VOC adhesive, Halstead, or approved equivalent.

2.07 JACKETING

A. Canvas Jacket: Ul listed fabric, 6 ounce/sq. yd., plain weave cotton treated with dilute fire retardant lagging adhesive.

B. PVC preformed molded insulation covers. Zeston or approved equivalent.

C. Aluminum Jacket: 0.016-inch-thick sheet, (smooth/embossed) finish, with longitudinal slip joints and 2-inch laps, die-shaped fitting covers with factory attached protective liner.

D. Stainless Steel Jacket: Type 304 stainless steel, 0.010-inch, smooth finish.

2.08 ACCESSORIES

A. Equipment Insulation Jacketing: Presized glass cloth, not less than 7.8 ounces/sq.yd., except as otherwise indicated. Coat with gypsum based cement.

B. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

C. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have the same flame and smoke component ratings as the insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide nonwater

soluble treatments. Provide UV protection recommended by manufacturer for outdoor installation.

2.09 DUCT INSULATION ACCESSORIES

A. Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

2.10 DUCT INSULATION COMPOUNDS

A. Cements, adhesives, coatings, sealers, protective finishes and similar accessories as recommended by insulation manufacturer for applications indicated. Comply with South Coast Air Quality Management District (SCAQMD) Rule #1168 in accordance with LEED EQ 4.1.

PART 3 - EXECUTION

3.01 VERIFICATION OF CONDITIONS

A. Do not apply insulation until pressure testing of the ducts and piping has been completed. Do not apply to pipe with heat tracing until system has been tested. Do not apply insulation until the duct has been inspected.

B. Examine areas and conditions under which duct and pipe insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and dry surfaces to be insulated.

3.03 INSTALLATION

A. Insulation: Continuous through walls, floors, partitions except where noted otherwise.

B. Piping and Equipment:
   1. Install insulation over clean, dry surfaces with adjoining Sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until piping has been leak tested and has passed such tests. Do not insulate manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears. Insulate elbows, flanges, valves, and unions with same thickness as that used for piping.

C. Ductwork:
   1. Install insulation in conformance with manufacturer's recommendations to completely cover duct.
   2. Butt insulation joints firmly together and install jackets and tapes smoothly and securely.
   3. Apply duct insulation continuously through sleeves and prepared openings, except as otherwise specified. Apply vapor barrier materials to form complete unbroken vapor seal over insulation.
   4. Coat staples and seals with vapor barrier coating.
   5. Cover breaks in jacket materials with patches of same material as vapor barrier. Extend patches not less than 2-inches beyond break or penetration on all directions and secure with adhesive and staples. Seal staples and joints with vapor barrier coating.
   6. Fill jacket penetrations. i.e., hangers, thermometers and damper operating rods, and other voids in insulation with vapor barrier coating. Seal penetration with vapor barrier coating. Insulate Hangers and Supports for cold duct in un-conditioned spaces to extent to prevent condensation on surfaces.
   7. Seal and flash insulation terminations and pin punctures with reinforced vapor barrier coating.
   8. Continue insulation at fire dampers and fire/smoke dampers up to and including those portions of damper frame visible at outside of the rated fire barrier. Insulating terminations at fire dampers in accordance with this Section.
   9. Do not conceal duct access doors with insulation. Install insulation terminations at access door in accordance with this Section.

10. Duct Liners: Mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with continuous (minimum 90) percent coat of adhesive. For widths over 20-inches, additionally secure liner with mechanical fasteners 15-inches on center or per manufacturer requirements. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom Sections of insulation overlap sides. Factory/field coat exposed edges. Metal nosing for exposed lending edges and when velocity exceeds 3500 FPM or manufacturer rating on exposed edges. Keep duct liner clean and free from dust. At completion of project, vacuum duct liner if it is dirty or dusty. Cut studs off near washers. Do not use small pieces. If insulation is installed without horizontal, longitudinal, and end joints butted together, installation will be rejected and work removed and replaced with work that conforms to this Specification.
11. Duct Wrap: Cover air ducts per insulation table except ducts internally lined where internal duct lining is adequate to achieve adequate insulating values to meet local Energy Codes (indicate on shop drawings, locations where duct wrap is planned to be omitted and indicate internal duct lining insulating values to confirm they will meet the Energy Code.) Wrap tightly with circumferential joints butted and longitudinal joints overlapped minimum of 2-inches. Adhere insulation with 4-inch strips of insulating bending adhesive at 8-inches on center. On ducts over 24-inches wide, additionally secure insulation with suitable mechanical fasteners at 18-inches on center. Circumferential and longitudinal joints stapled with flare staples 6-inches on center and covered with 3-inch wide, foil reinforced tape.

D. Insulated Pipe Exposed to Weather:
1. Where piping is exposed to weather, cover insulation with aluminum jacket. Seal watertight jacket per manufacturer's recommendations. Install metal jacket with 2-inch overlap at longitudinal and butt joints with exposed lap pointing down. Secure jacket with stainless steel drawn bands 12-inches on center and at butt joints. See Section 23 05 33, Heat Tracing for HVAC.

E. Insulation Shields:
1. Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, non-compressible insulation. Section at insulation shields for lines 2-inches and larger for steam and chilled water piping.

3.04 PROTECTION AND REPLACEMENT

A. Installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

3.05 FIBERGLASS INSULATION

A. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate the vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.

B. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use performed PVC molded insulation covers.

3.06 LABELING AND MARKING

A. Provide labels, arrows and color on piping and ductwork. Attach labels and flow direction arrows to the jacketing per Section 23 05 53, Identification for HVAC Piping, Ductwork and Equipment.

3.07 PIPING SURFACES TO BE INSULATED

A. Oregon:

Item to be Insulated	System Insulation Type	Conductivity Range (Btu-inch per hour per SF per degrees F)	Pipe Size (inches)	Indoor Location Insulation Thickness (inches)	Outdoor Location Insulation Thickness (inches)
Hydronic piping systems	1	0.25-0.29 at a mean rating temperature of 125 degrees F	<1 1 to <1.5 1.5 to <4 4 to < 8	1.5 1.5 2.0 2.0	2.5 2.5 3.0 3.0
Heating, Steam and Condensate (201F to 250F)	1	0.27-0.30 at a mean rating temperature of 150 degrees F	<1 1 to <1.5 1.5 to <4 4 to <8 >=8	2.5 2.5 2.5 3.0 3.0	2.5 2.5 2.5 3.0 3.0
Air Separation Tanks	1	0.24-0.28 at a mean rating temperature of 75 degrees F	N/A	2.0	3.0

B. Note: Insulation thickness shown is a minimum. If state code requires additional thickness, then provide insulation thickness per code requirements.

3.08 DUCTWORK SURFACES TO BE INSULATED

Item to be Insulated	System Insulation Type	Duct Size	Insulation Thickness
Supply ductwork where duct is not specified to be lined.	A	All	1-1/2-inch
Return ductwork where duct is not specified to be lined.	--	All	None
Outside Air Ducts	A	All	3-inch
HVAC plenums and unit housings not preinsulated	B	All	1-1/2-inch
Grease Exhaust	E	All	Per rating level
Exhaust ducts within 10-feet of exterior	A	All	3-inch

A. Note: Insulation thickness shown is a minimum. If state codes require additional thickness, then provide insulation thickness per code requirements.

3.09 FLEXIBLE ELASTOMERIC PLASTIC PIPE INSULATION

A. Slip insulation on pipe prior to connection. Butt joints sealed with manufacturer's adhesive. Insulate fitting with miter-cut pieces. Cover insulation exposed to weather and undergrade with two coats of finish as recommended by manufacturer.

3.10 FLEXIBLE ELASTOMERIC TUBING

A. Flexible Elastomeric Tubing: Slip insulation over piping or, if piping is already installed, slit insulation and snap over piping. Joints and butt ends must be adhered with 520 adhesive.

3.11 INSULATION SHIELDS

A. Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation Section at insulation shields for lines 2-inches and larger for steam and chilled water piping.

3.12 FIRE PROTECTION DUCTWRAP

A. Coordinate layers of wrap and thickness with required enclosure rating.

B. Minimum 3-inch overlap required on joints.

C. Cut edges and joints sealed with aluminum foil tape.

D. Install according to manufacturer's recommendations to maintain UL installation requirements.

E. Provide manufacturer's insulation system over duct access doors without impeding access.

F. Provide fire wrap on makeup air duct connections to hood within 18-inches of combustible construction.

3.13 PROTECTION AND REPLACEMENT

A. Protect installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

END OF SECTION

SECTION 23 0900

INSTRUMENTATION AND CONTROL PERFORMANCE SPECIFICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Communications
   2. Operator Interface
   3. Controller Software
   4. Web Based Access
   5. BAS Graphics
   6. Building Controllers
   7. Application Specific Controllers
   8. Advanced Application Controllers
   9. Application Specific Controller - Terminal Unit Controllers
   10. Input/Output Interface
   11. Power Supplies and Line Filtering
   12. Control Panels
   13. Auxiliary Control Devices
   14. Wiring and Raceways
   15. Smoke Detection for Projects with a Building Fire Alarm System

B. This is a performance specification and the district is responsible for design tasks and engineering. This is included only for reference. No work under this section is to be performed by the Contractor.

C. This information is provided for information only in coordinating this work with the district's controls installer. This work is to be done by the district's installer with work by other trades coordinated by the contractor.

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Current edition of ANSI/ASHRAE Standard 135 and addendum, BACnet.
   2. Current edition of UL 916 Underwriters Laboratories Standard for Energy Management Equipment, Canada and the US.
   3. Current edition of FCC Part 15, Subpart J, Class A.
   4. Current edition of BACnet Testing Laboratories (BTL).

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Prepare and submit a detailed schedule of work. Schedule to identify milestones such as equipment submittals, control panel diagrams, color graphic panel displays, Interlock.
   2. Wiring diagrams, control program sequence software flow chart diagrams, conduit layout diagrams, device location diagrams, equipment and component deliveries, installation sequencing, controller startup, point to point startup, control programming, sequence testing, commissioning/acceptance testing and training.
   3. Submit design drawings, sequences of operation, program listings, software flow charts and details for each typical piece of equipment and system being controlled. No work to

be initiated or fabrication of any equipment started prior to the Owner's Representatives return of REVIEWED submittals.

a. Sequence of Operation: Please note that the sequence of operation included in the design documents is intended only to communicate the Engineers' general control intent and is not to be used as a direct reference for programming of the EMS system. Verbatim duplication of the Engineer's Sequence of Operation on the submittals is discouraged and may result in non-approval of the submittal. Sequence of operation on submittals to accurately detail the system's intended programming, and include details of all enhancements, adjustments, or deviations from the Engineer's sequence of operation. Submitted sequence of operation to be written with a logical and organized format and flow. Provide detailed, clear and unambiguous sequence of operation language. Point descriptors and point nomenclature referenced in the submitted sequence of operation to match those (to be) actually programmed. As-built submittal Sequence of Operation to include all modifications to the programming made as a result of any addendum, bulletins, RFI's, change orders, and commissioning.

4. Format: Make each submittal in one complete and contiguous package. Partial or unmarked submittals will be rejected without review.
5. Submit Manufacturers Data as Follows:
   a. Complete materials list of items proposed to be furnished and installed. A complete Bill of Materials, listing materials, components, devices, wire and equipment are required for this work. The Bill of Materials to be separate for each controller on its own page(s) and to contain the following information for each item listed:
      1) Manufacturer's Name and Model number with furnished options highlighted.
      2) Quantity of each by controller location.
      3) Description of product (generic).
      4) Specified item.
      5) Operating range or span.
      6) Operating point or set point.
   b. Manufacturer's specifications and other data required demonstrating compliance with the specified requirements, including but not limited to: Catalog cuts, technical data and descriptive literature on hardware, software, and system components to be furnished.
   c. The data to be clearly marked and noted to identify specific ranges, model numbers, sizes, and other pertinent data. Submit printed manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials and including printed installation instructions and start-up instructions.
   d. Unless specifically called for otherwise, provide bound copies of catalog cuts for standard products, not requiring specifically prepared Shop Drawings, for the following:
      1) Wire and Cable, Class II
      2) Face Plates for Devices
      3) Disconnect Switches for Power Control
   e. Where more than one item, size, rating or other variations appear on a catalog cut sheet, clearly identify items to be provided. These items to be properly indexed and referenced to identification numbers, designations and/or details on the Drawings.
6. Shop Drawings: Submit shop drawings for each controlled system, depicting the following information:
   a. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves and other control/monitoring devices.
   b. Label each control device with initial setting or adjustable range of control. Label points in schematic diagrams with termination at corresponding controller.
   c. Electrical Wiring: Clearly differentiate between portions of wiring that are factory installed and portions of be field-installed.

d. Details of control panel faces, including controls, instruments, and labeling.
e. Interfaces to equipment furnished under other Sections identifying numbers of wires, termination location, voltages and pertinent details. Responsibility for each end of the interfaces to be noted on these drawings whether or not they are a part of this Section.

7. Equipment locations, wiring and piping schematics, details, panel configurations, sizes, damper motor mounting details, valve schedules, and a points list keyed to specific hardware submittals. Control wiring depicted as fully annotated ladder diagrams with terminations identified, completely configured as to the exact panel, wiring, relay, switch, and component configuration.
8. Tag Number Lists: Develop instruments tag number system and submit list for approval. Coordinate methods and number block with the Owner Representative.
9. Format the Shop and Field Drawings to Include:
   a. A Title Sheet containing a drawing list, abbreviations list, symbols list, site and vicinity maps for project location and schedules.
   b. Floor Plans showing proposed device locations and device nomenclatures.
   c. A Riser Diagram illustrating conduit relationships between devices shown on the Floor Plans. Show device nomenclatures.
   d. A Single-Line Diagram for each system showing signal relationships of devices within the system. Show device nomenclatures.
   e. A Wiring Diagram for each assembly, enclosure or free standing device, showing:
      1) The Devices Within
      2) Wiring Connections
      3) Wire Identification
      4) Voltage Levels
      5) Fuse Ratings
   f. Operations and Maintenance Manuals:
      1) Following approval of Shop Drawings of control equipment and prior to acceptance of control work, prepare Operating and Maintenance manuals describing operating, servicing, and maintenance requirements of control systems and equipment installed under this Section, in accordance the General and Special Conditions of these Specifications.
      2) Information contained in the manual for the above equipment to include the following:
         (a) Manufacturer's catalog cuts and printed descriptive bulletins.
         (b) Manufacturer's installation, operating, and maintenance instruction booklets. Complete instructions regarding the operation and maintenance of equipment involved.
         (c) Instrument calibration certificates.
         (d) Parts list and costs.
         (e) Complete nomenclature of replaceable parts, list of recommended spare parts for 12 months operation, their part numbers, current cost and name and address of the nearest vendor of replacement parts.
         (f) Name, address and telephone number for closest source of spare parts.
         (g) Wiring and schematic diagrams.
         (h) Include final record copies of shop drawings.
         (i) Copy of guarantees and warranties issued for the various items of equipment, showing dates of expiration.
         (j) Reduced plans, diagrams, and control schematics.
         (k) Copies of test results.
         (l) Control System Operating Manual including: point of summary and point data base; complete printout of program listings; magnetic tape CD or DVD backup of Field Control Cabinet programs; cabinet layout; hard copy of graphic screens; hard copy of specified reports.

g. A final Bill of Quantities including a separate schedule for portable equipment, if delivered as part of this work.
h. Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified in these specifications.
i. Record Drawings: Comply with Division 01, General Requirements and Section 23 00 00, HVAC Basic Requirements. Provide complete as-built submittals including "as-programmed" sequence of operation as well as final occupancy schedules.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
1. Installer Qualifications: Company specializing in performing work of the type specified in this Section with minimum five year's experience in the local area. Installers required to have successfully completed manufacturer's control system factory training.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 SYSTEM DESCRIPTION

A. Control system referenced throughout specifications and drawings as Building Automation System (BAS), Building Management System (BMS), or Energy Management System (EMS) interchangeably consists of high-speed, peer-to-peer network of DDC controllers, control system server, and operator workstation.

B. System software based on server/thin-client architecture, designed around open standards of web technology. Control system server accessed using a web browser over control system network, Owner's local area network, and remotely over Internet (through Owner's LAN).

C. Intent of thin-client architecture is to provide operators complete access to control system via web browser. No special software other than web browser required to access graphics, point displays, and trends.

D. Local Area Network (LAN) either 10 or 100 Mpbs Ethernet network.

E. System will consist of open architecture that is capable of:
1. High speed Ethernet communication using TCP/IP protocol
2. Native BACnet communications according to ANSI / ASHRAE Standard 135, latest edition.
a. Provide necessary BACnet-compliant hardware and software to meet the system's functional specifications. Controller devices must be BTL tested and listed by an official BACnet Testing Laboratory and have the BTL mark issued.

F. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation valves and dampers.

G. Prepare individual hardware layouts, interconnection drawings, building riser/architecture diagram and sequence of control from the project design data. Any architecture diagrams on design drawings have been included as schematics only and are not meant to portray quantity of devices or power/data requirements.

H. Design, provide, and install equipment cabinets, panels, data communication network infrastructure (including cables, conduits, outlets, connections, etc.) needed, and associated hardware.

I. Provide complete manufacturer's specifications for items that are supplied. Include vendor name and model number of every item supplied.

J. Provide a comprehensive operator and technician training program as described in these specifications.

K. Provide as-built documentation, operator's terminal software, diagrams, and other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

L. Provide 120V power, low voltage power, transformers, etc. for control panels, transformer panels, and BAS devices. Install per Division 26, Electrical specifications. Power for devices within this specification Section are solely the responsibility of the BAS Contractor.

M. Conduit and raceway systems. Install per Division 26, Electrical specifications.

N. All devices, components, controllers, and software to be manufacturer's most current version at the time of installation.

1.08 SYSTEM PERFORMANCE

A. Performance Standards - System conforms to following minimum standards over network connections:
   1. Graphic Display: Graphic with 20 dynamic points display with current data within 10 seconds.
   2. Graphic Refresh: Graphic with 20 dynamic points update with current data within 8 seconds.
   3. Object Command: Devices react to command of binary object within 2 seconds. Devices begin reacting to command of analog object within 2 seconds.
   4. Object Scan: Data used or displayed at controller or workstation have been current within previous 6 seconds.
   5. Alarm Response Time: Object that goes into alarm be annunciated at workstation within 45 seconds.
   6. Program Execution Frequency: Custom and standard applications be capable of running as often as once every 5 seconds. Select execution times consistent with mechanical process under control.
   7. Performance: Programmable controllers be able to completely execute DDC PID control loops at frequency adjustable down to once per second. Select execution times consistent with mechanical process under control.
   8. Multiple Alarm Annunciation: Each workstation on network receive alarms within 5 seconds of other workstations.

B. Reporting Accuracy: System reports values with minimum end-to-end accuracy listed in Reporting Accuracy Table below.
   1. Reporting Accuracy Table:

Measure Variable	Reported Accuracy
Space Temperature	Plus or Minus 1 degree F
Ducted Air	Plus or Minus 1 degrees F
Outside Air	Plus or Minus 2 degrees F
Water Temperature	Plus or Minus 1 degree F
Delta-T	Plus or Minus 0.25 degree F
Water Flow	Plus or Minus 2 percent of full scale

   2. Note 1: Accuracy applies to 10 percent-100 percent of scale
   3. Note 2: For both absolute and differential pressure
   4. Note 3: Not including utility-supplied meters

C. Control Stability and Accuracy. Control loops maintain measured variable at set point within tolerances listed in Control Stability and Accuracy Table below.
   1. Control Stability and Accuracy Table:

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	Plus or minus 0.2 inch wg	0-6 inch wg
	Plus or minus 0.01 inch wg	-0.1 to 0.1 inch wg

Controlled Variable	Control Accuracy	Range of Medium
Airflow	Plus or minus 10 percent of full scale	
Space Temperature	Plus or minus 2.00 degrees F	
Duct Temperature	Plus or minus 3.0 degrees F	
Fluid Pressure	Plus or minus 1.5 PSI	1-150 PSI
	Plus or minus 1.0 inch wg	0-50 inch wg differential

PART 2 - PRODUCTS

2.01 4J DISTRICT APPROVED MANUFACTURERS/INSTALLERS

A. Automated Logic (ALC)/Clima-Tech

2.02 COMMUNICATIONS

A. Each controller to have communication port for connection to operator interface.
   1. Internetwork operator interface and value passing to be transparent to internetwork architecture.
   2. Operator interface connected to controller to allow operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, reports, system software, and custom programs to be viewable and editable from each internetwork controller.

B. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers to be readable by each controller on internetwork.

C. Operator Workstation to be capable of simultaneous direct connection and communication with BACnet/IP, OPC and TCP/IP networks without use of interposing devices such as PC or gateway with hard drive.

D. Workstations, Building Control Panels and Controllers with real-time clocks use time synchronization service. System automatically synchronizes system clocks daily from operator-designated device via internetwork. System automatically adjusts for daylight savings and standard time as applicable.

2.03 OPERATOR INTERFACE

A. Operator Interface: PC-based workstations reside on high-speed network with building controllers. Each workstation or each standard browser connected to server be able to access system information.

B. Hardware: Each operator workstation or web server consists of the following:
   1. Computer: Hardware meets or exceeds DDC system manufacturer's recommended specifications and meet response times specified elsewhere in this document. Following hardware requirements also apply:
      a. Hard disk have sufficient memory to store:
         1) Required operator workstation software.
         2) One year of trend data based on points specified to be trended at specified trend intervals.
      b. Minimum hardware configuration includes:
         1) Intel i7 Processor
         2) 8 GB of RAM
         3) 48x CD-RW/DVD Optical Drive
         4) 1 TB Hard Disk Drive Providing Data at 3 GB/sec
         5) Ethernet 10/100 Network Interface Card
         6) High Performance Graphics Card
         7) 22-in LCD Monitor with at least 1024 x 768 Resolution
         8) Keyboard and Mouse
         9) Color Inkjet Printer

10) UPS (uninterruptible power supply) installed at server, sized with sufficient capacity to allow full operation for 10 minutes or more.

C. System Software:
1. Operating System: Furnish concurrent multi-tasking operating system. Operating system also supports use of and includes other common software applications such as Microsoft Excel, Word, Microsoft Access and Adobe Acrobat. Acceptable operating systems are Windows XP and Windows 7.
2. Dynamic Color Graphics:
   a. Real-time color graphic displays dynamic and able to update displays.
   b. Provide operator ability to change values (set points) and states in system controlled equipment directly from graphic display.
   c. Custom Graphics. Provide custom graphics generation package.
   d. Graphics Library. Furnish library of standard HVAC equipment graphics and include standard symbols for fans, pumps, coils, valves, piping, dampers, and ductwork.
3. All software to be manufacturer's most current version at the time of installation.

D. System Applications: Each workstation provides operator interface and off-line storage of system information. Provide following applications at each workstation:
1. Automatic System Database Save and Restore: Each workstation stores on hard disk copy of current database of each Building Controller. This database automatically updated whenever change is made in any system panel.
2. Manual Database Save and Restore: System operator able to manually save or clear database and initiate download of specified database from/to any panel.
3. System Configuration: Workstation software provides method of configuring system to allow for changes or additions by users and performs following tasks:
   a. Create, delete or modify control strategies.
   b. Add/delete objects to system.
   c. Tune control loops through adjustment of control loop parameters.
   d. Enable or disable control strategies.
   e. Generate hard copy records of control strategies on printer.
   f. Select points to be alarmed and define alarm state.
   g. Select points to be trended and initiate automatic recording of values.
   h. Start/Stop binary objects and adjust analog objects.
4. Security: Operator required to log on to system with user name and password in order to view, edit, add, or delete data. System security selectable for each operator.
5. System Diagnostics: System automatically monitor operation of workstations, printers, modems, network connections, building management panels, and controllers. Failure of any device to be annunciated.
6. Alarm Indication and Handling:
   a. Workstation provides visual means of alarm indication. Alarm indication becomes highest priority regardless of application(s) running.
   b. System provides and archive log of alarm messages to hard drive. Alarm messages to include description of event-initiating object, source, location and time/date of alarm.
7. Trend Logs: Operator able to define custom trend log for any data object and include interval, start time, and stop time. Trend data sampled and stored on building controller panel, be archived on hard disk, and be retrievable for use in spreadsheets and standard database programs.
   a. System server to periodically gather historically recorded data stored in the building controllers and archive the information. Archived files to be appended with new sample data, allowing samples to be accumulated.
   b. Software to be included that is capable of graphing the trend logged object data. Software capable of creating two-axis (x,y) graphs that display object values relative to time.

c. Operator able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. Input, output, and value object types in the system may be logged. Provide operations password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.
d. BAS Contractor to enable trending for any and all system points (physical or virtual) as directed by the Engineer, Owner or Commissioning Authority (Commissioning Authority). There will be no limit on the number of trended points the BAS Contractor is to set up. BAS Contractor will modify trend setup parameters as directed by the Commissioning Authority during testing. BAS Contractor to be proactive and enable trending for all major system points during system startup/programming. BAS Contractor is not to wait for direction to begin trending points. Trend data for each point to be archived on the main server for a minimum of one year. Trend data archiving to be enabled immediately upon trend setup, or as soon as communication between the field panel and sever is established. Trend data uploads from field panel to server set up to be automatically performed with sufficient frequency to ensure no data gaps or loss of trend data.
e. Trend points as identified in the points list. Provide system specific trend data in two-axis (x,y) graphs that display object values relative to time to Engineer, Owner, or Commissioning Authority.

8. Standard Reports: Standard system reports provided for this project. Provide ability for Owner to readily customize these reports for this project:
   a. Objects: System (or subsystem) objects and their current values.
   b. Logs:
      1) Alarm History
      2) System Messages
      3) System Events
      4) Trends

E. Interfaces to Third Party Systems: BAS connects to third party systems (VFDs, chillers, emergency generators, rooftop AC units, etc.). Communication protocol specified for third party system, and BAS provides compatible protocol to assure proper two way communication. Points, alarms, and commands displayed on BAS as indicated.

F. Workstation Applications Editors: Each PC workstation supports editing of system applications, which downloaded and executed at one or more controller panels.

2.04 CONTROLLER SOFTWARE

A. Furnish following applications software for building and energy management. Software applications reside and operate in system controllers. All software to be manufacturer's most current version at the time of installation. All software and associated functions (scheduling, optimum start/stop, etc.) noted in this specification are to be configured and enabled for this project. Incorporate into sequence of operation submittals for review prior to installation.

B. System Security:
   1. User access secured using individual security passwords and user names.
   2. Record user Log On/Log Off attempts.
   3. Provide passwords, user names, and access assignments adjustable at the operator's terminal. Each user to have a set security level, which defines access to displays and individual objects the user may control. System to include 10 separate and distinct security levels for assignment to users.
   4. System to include an Auto Logout Feature that will automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period to be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal to display message on screen that user is logged out after Auto Logout occurs.

C. Scheduling: Provide capability to schedule each object or group of objects in system. Coordinate schedule with Owner and program accordingly. Each schedule consists of:

1. Operator's workstation to show information in easy-to-read daily format. Priority for scheduling: Events, holidays and daily with events being the highest.
2. Holiday and special event schedules to display data in calendar format. Operator able to schedule holidays and special events directly from these calendars.
3. Operator able to change information for a given weekly or exception schedule if logged on with the appropriate security access.

D. Optimum Start/Stop: Provide software and program system to start equipment on sliding schedule based upon indoor and outdoor conditions. Determine minimum time of HVAC system operation needed to satisfy space environmental requirements and also determine earliest possible time to stop mechanical systems (i.e. hut down cooling/heating and only provide ventilation one hour prior to scheduled unoccupied period.) Optimum start/stop program operates in conjunction with scheduled start/stop and night setback programs.

E. Alarms:
1. Operator's workstation to provide visual means of alarm indication. The alarm dialog box to always become the top dialog box regardless of the application(s), currently running.
2. System to provide log of alarm messages. Alarm log to be archived to the hard disk of the system operator's terminal. Each entry to include a description of the event-initiating object generating the alarm. Entry to include time and date of alarm occurrence.
3. Alarm messages in user-definable text and entered either at the operator's terminal or via remote communication.
4. Each binary object set to alarm based on operator-specified state.
5. Each analog object have both high and low alarm limits.
6. Alarms must be able to be automatically and manually disabled.
7. Alarms be routed to appropriate workstations based on time and other conditions. An alarm able to start programs, print, be logged in event log, generate custom messages, and display graphics.
8. System have ability to dial out in event of alarm.

F. Demand Limiting:
1. System to include demand limiting program that includes two types of load shedding. One type of load shedding to shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding to adjust operator selected control set points in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.
2. Status of each and every load shed program capable of being displayed on every operator terminal connected to system. Status of each load assigned to an individual shed program displayed along with the description of each load.
3. Demand-limiting program monitor building power consumption from signals generated by pulse generator (provided by BAS contractor) mounted at building power meter or from watt transducer or current transformer attached to building feeder lines.
4. Demand-limiting program predicts probable power demand so that when demand exceeds demand limit, action will be taken to reduce loads in predetermined manner. When demand limit will not be exceeded, action will be taken to restore loads in predetermined manner.

G. Maintenance Management: System monitors equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits. Coordinate settings with Owner.

H. Sequencing: Provide application software based upon sequences of operation specified to properly sequence designated systems. Provide all points to achieve specified sequences.

I. Staggered Start: This application prevents controlled equipment from simultaneously restarting after a power outage. Order in which equipment (or groups of equipment) is started, along with time delay between starts to be user-selectable.

J. Energy Calculations: Provide software to allow instantaneous power (9e.g. kW) or flow rates (e.g. L/s (gpm)) to be accumulated and converted to energy usage data.

K. Anti-Short Cycling: Binary output objects protected from short cycling by allowing minimum on-time and off-time to be selected.

L. On/Off Control with Differential: Provide algorithm that allows binary output to be cycled based on controlled variable and set point. Algorithm direct-acting or reverse-acting and incorporate adjustable differential.

M. Run-Time Totalization: Provide software to totalize run-times for binary input objects.

2.05 WEB BASED ACCESS

A. General Description: BAS supplier to provide web-based access to the system as part of standard installation. Provide access to user of displays of real-time data that are part of the BAS via a standard Web browser. Web browser to tie into the network via Ethernet network connection. Provide web-page host that resides on the BAS network. Web-page software not to require a per user licensing fee or annual fees. The web-page host must be able to support at least 50 simultaneous users with the ability to expand the system to accommodate an unlimited number of users. Software to be manufacturer's most current version at time of installation.

B. Browser Technology: Browser to be standard version of Microsoft Internet Explorer (latest edition). No special vendor-supplied software needed on computers running browser. Displays viewable and the Web-page host to directly access real-time data from the BAS network. Data displayed in real time and update automatically without user interaction. User able to change data on displays if logged in with the appropriate user name and password.

C. Display of Data: Web page graphics shown on browser to be replicas of the BAS displays. User to need no additional training to understand information presented on Web pages when compared to what is shown on BAS displays. Web page displays to include animation just as BAS displays. Fans to turn, pilot lights to blink, and coils to change colors, and so on. Real-time data shown on browser Web pages. This data must be directly gathered via the BACnet network and automatically updated on browser Web page displays without any user action. Data on the browser to automatically refresh as changes are detected without re-drawing the complete display. User to be able to change data from browser Web page to if the user is logged on with the appropriate password. Clicking on a button or typing in a new value to change digital data. Using pull-down menus or typing in a new value to change analog data. Data displays navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.

D. Web Page Generation: Web pages generated automatically from the BAS displays that reside on the BAS server. User to access Web-page host via the network and initiate a web page generation utility that automatically takes the BAS displays and turns them into Web pages. The Web pages generated are automatically installed on the Web page host for access via any computer's standard browser. Any system that requires use of an HTML editor for generation of Web pages will not be considered.

E. Password Security and Activity Log: Access via Web browser to utilize the same hierarchical security scheme as BAS system. User asked to log in once the browser makes connection to Web-page host. Once the user logs in, any and all changes that are made to be tracked by the BAS system. User able to change only those items that the user has authority to change. A user activity report to show any and all activity of the users that have logged in to the system regardless of whether those changes were made using a browser or via the BAS workstation.

F. Communication: Web-page host to communicate using the specified protocol standard to devices on the BAS network.

2.06 BAS GRAPHICS

A. Develop customized graphics showing the project building(s) and their floor plans, mechanical, and electrical equipment, flow and control diagrams, and other relevant features on Workstation graphic screens. Associated input, output, and virtual objects (e.g., temperature and pressure

set points) listed in the Sequence of Operation, and shown on the Input/Output Objects List included in the graphic screens and bound to the database. Real-time value of objects updated on the display of each graphic automatically. For projects where existing campus and/or building controls systems exist, replicate graphics used in the existing BAS graphics screens.

B. Graphics to have links to the Print function and to display a Standard Legend in the corner of the graphic. Graphics, except pop-ups, to have the date and time displayed in the upper corner of the graphic. Each graphic titled.

C. Weather: Graphics, except pop-ups, to have the outdoor temperature and humidity in the upper corner of the graphic.

D. Alarms: System and component summary alarms located near the top of each relevant graphic screen. Provide links to the associated system/component as part of these tags to assist trouble shooting. Other alarms placed near the associated system/device as depicted in the graphic. Provide text and color of information tags that describe each object and alarm value consistent with a graphics color legend.

E. The Following Graphics Provided as a Minimum:
   1. A building graphic, typically a photograph of the building, with links to each floor plan and other links as defined below.
   2. A central plant graphic with equipment (chillers, boilers, pumps, heat exchangers, storage tanks, etc.), temperature sensors, pressure sensors, flow sensors and refrigeration leak detectors. The central plant graphic to have links to each building on the campus.
   3. Central equipment such as air handler, package rooftop equipment, supply fans, exhaust fans, and smoke control systems.
   4. Floor plans of each floor, with temperature sensors, pressure sensors, temperature control zones, heating/cooling zones, ventilation zones, and supply air zones identified. Rooms grouped on a graphic only to the extent that detailed and complete sensing information can be comfortably viewed by an operator and the bound points updated in less than 10 seconds. Each zone to have a temperature symbol that changes color over the range from low (blue) through normal (green) to high (red) and indicate an alarm (flashing red). The zone temperature and or pressure symbol(s) to be a link to a zone control pop-up graphic. Individual floor plan graphics to provide links to related mechanical systems. The mechanical room plan graphics to show the relative location of, and provide links to, either the equipment pop-up or flow and control graphic for mechanical equipment monitored or controlled by the BAS.
   5. Pop-up graphics provided for each zone control system showing a flow diagram and related monitoring and control points and system parameters. Pop-up graphics provided for each piece of equipment that is not shown on a flow and control graphic.
   6. Flow and control diagrams for each system including but not limited to central plant, fan coils, generators, packaged equipment, chilled water systems, heating hot water systems, heat exchangers, pumps, storage tanks, zone terminal units, isolation room systems, smoke damper status, combination fire and smoke dampers status, and ventilation systems. The flow and control graphics to have parameters grouped in the lower portion of the graphics. Standard equipment graphics used. Pumps, fans, dampers and other elements to dynamically indicate their state (i.e. pumps and fans to rotate when on and damper positions to dynamically adjust and be shown in their current position, etc.). System flow and control graphics displayed in a general left to right flow or loop arrangement. Return and exhaust air flow shown on top and return water shown on the bottom of the graphic.
   7. Individual equipment/component screens showing sensing and control information available for each device provided.

F. Penetration: The graphic interface to consistently apply a convention whereby a left-click to always penetrate to more detailed information. The text windows to represent the deepest level of penetration. A right-click to always produce a menu of options that are specific to the item selected.

G. Navigation: Graphics organized to provide a "branching structure" that allows an operator to move from a "macro view" to a "micro view" and return. These links to other associated graphics, or allow a return to a previous macro view, provided and arranged horizontally along the bottom of each graphic screen. From left to right, the graphic links as follows: site/building map, building/trailer floor plans, and major mechanical systems at each building. Pop-up right click menus provided as needed on the lower button bar to allow for uncluttered navigation.

H. Clutter Minimization: Each graphic to have separate check boxes in the lower right corner that show/hide set points, alarms/safeties, and devices/equipment.

I. Templates: To the maximum extent possible, use standard graphics as templates to provide a consistent look throughout the interface.

J. Color Scheme: The graphics to use dynamic color changes to communicate equipment type, or object status consistent with the graphics color legend.

K. Symbols and Animations: Fans, pumps, dampers, coils, and generation equipment to be dynamic symbols indicating rotation, state, or position, movement, flow, etc.

L. Macros: When macros are used to add functionality to the graphics, detailed documentation provided.

M. Configure Mode: Access to “Configure Mode” for editing of the graphics password protected to prevent unauthorized changes to the graphics. This password supplied to the appropriate personnel.

N. Graphics Version: Graphics provided in the most current format available at time of control system programming.

O. Points and graphics checked for the proper binding and graphic programming, settings to ensure that the correct system, location, point values and dynamics are shown in the proper location and rotate in the proper directions.

P. After graphics have been accepted, provide, on a CD ROM in an agreed upon file structure. If the graphics have active-x controls or other files that must be placed outside the graphics folder structure a set-up program provided on the disk to place the files in the correct locations.

2.07 BUILDING CONTROLLERS

A. General: Provide adequate number of building controllers to achieve performance specified. Panels to meet the following requirements.
   1. Building Automation System (BAS) to be composed of one or more independent, stand-alone, microprocessor-based building controllers to manage global strategies described in Controller Software Section.
   2. Provide sufficient memory to support operating system, database, and programming requirements.
   3. Share data between networked building controllers.
   4. Distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
   5. Controllers that perform scheduling have real-time clock.
   6. Continually check status of its processor and memory circuits and if abnormal operation is detected, controller:
      a. Assume predetermined failure mode.
      b. Generate alarm notification.
   7. Building Controller communicates with other devices on internetwork including BACnet communications according to specified protocol.

B. Communication:
   1. Each building controller resides on network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and performs routing to network of custom application and application specific controllers.
   2. Controller provides a service communication port for connection to a portable operator's terminal.

C. Environment:
   1. Controllers used outdoors and/or in wet ambient conditions mounted within NEMA waterproof enclosures and rated for operation at 0 degrees F to 150 degrees F.
   2. Controllers used in conditioned space be mounted in NEMA dust-proof enclosures and rated for operation at 32 degrees F to 120 degrees F.

D. Serviceability: Provide diagnostic LEDs for power, communication, and processor. Wiring connections be made to modular terminal strips or to termination card connected by ribbon cable.

E. Memory: Building controller maintains BIOS and programming information in event of power loss for at least 72 hours.

F. Immunity to power and noise. Controller able to operate at 90 percent to 110 percent of nominal voltage rating and performs an orderly shutdown below 80 percent nominal voltage. Operation be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3-feet.

G. Controller to have a battery to provide power for orderly shutdown of controller and storage of data in nonvolatile flash memory. Battery backup to maintain real-time clock functions for a minimum of 10 days.

2.08 APPLICATION SPECIFIC CONTROLLERS

A. Application specific controllers (ASCs) are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers to be fully programmable using graphical programming blocks.
   1. ASC controllers communicate with other devices on internetwork.
   2. Each ASC capable of stand-alone operation without being connected to network.
   3. Each ASC will contain sufficient I/O capacity to control target system.
   4. Application controllers to include universal inputs with minimum 10-bit resolution that accept thermistors, 0-10VDC, 0-5 VDC, 4-20 mA and dry contact signals. Any input on a controller may be either analog or digital with at least 1 input that accepts pulses. Controller to also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller to include binary and analog outputs on board. Provide analog outputs switch selectable as either 0-10VDC or 0-20mA. Software to include scaling features for analog outputs. Application controller to include 24VDC voltage supply for use as power supply to external sensors.
   5. Program sequences stored on board application controller in EEPROM. No batteries needed to retain logic program. Program sequences executed by controller 10 times per second and capable of multiple PI and PID loops for control of multiple devices. Calculations completed using floating-point math and system to support display of information in floating-point nomenclature at operator's terminal. Programming of application controller completely modifiable in the field over installed BAS LANs or remotely via modem interface. Operator to program logic sequences by graphically moving function blocks on screen and tying blocks together on screen.
   6. Application controller to include support for room sensor. Display on room sensor programmable at application controller and include an operating mode and a field service mode. Provide button functions and display data programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

B. Communication:
   1. Controller resides on network using MS/TP Data Link/Physical layer protocol.
   2. Each controller connected to building controller.
   3. Each controller capable of connection to laptop computer or portable operator's tool.

C. Environment:
   1. Controllers used outdoors and/or in wet ambient conditions mounted within NEMA waterproof enclosures and rated for operation at 0 degrees F to 150 degrees F.
   2. Controllers used in conditioned space mounted in NEMA dust-proof enclosures and rated for operation at 32 degrees F to 120 degrees F.

D. Serviceability: Provide diagnostic LEDs for power, communication, and processor.

E. Memory: ASC use nonvolatile memory and maintains BIOS and programming information in event of power loss.

2.09 ADVANCED APPLICATION CONTROLLERS

A. General:
   1. Expandable application controller capable of providing control strategies for the system based on information from any or all connected inputs. Provide program implementing these strategies completely flexible and user definable. Provide program execution of controller a minimum of once per second.
   2. Programming: Object-oriented using control program blocks. Controller to support a minimum of 500 Analog Values and 500 Binary Values. Each and every analog and binary value to support standard specified protocol priority arrays.
   3. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed via the operator's terminal or field computer.
   4. Controller to have adequate data storage to ensure high performance and data reliability. Battery to retain static RAM memory and real-time clock functions for a minimum of 1.5 years (cumulative). Provide field-replaceable battery (non-rechargeable) lithium type. Unused battery life: 10 years.
   5. The onboard, battery-backed real time clock must support schedule operations and trend logs.
   6. Global control algorithms and automated control functions should execute via 32-bit processor.
   7. Controller to include both on-board Ethernet specified protocol communication over twisted pair cable (UTP) and to include specified protocol IP communication. In addition, controller to include specified protocol PTP connection port.
   8. The base unit of the controller to host up to 8 expansion modules with various I/O combinations. These inputs and outputs to include universal 12-bit inputs, binary triac outputs, and 8-bit switch selectable analog outputs (0-10V or 0-20 mA). Inputs to support thermistors, 0-5VDC, 0-10VDC, 4-20mA, dry contacts and pulse inputs directly.
   9. Outputs must have onboard Hand-Off-Auto switches and a status indicator light. HOA switch position to be monitored. Each analog output to include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.
   10. The position of each and every HOA switch to be available system wide as a specified protocol object. Expandable Controller to provide up to 176 discreet inputs/outputs per base unit.

B. Schedules: Each controller to support a minimum of 50 Schedule Objects.

C. Logging Capabilities: Each controller to support a minimum of 200 trend logs. Any object in the system (real or calculated) may be logged. Sample time interval adjustable at the operator's workstation.

D. Alarm Generation:
   1. Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
   2. Alarm log provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site via remote communications.
   3. Controller must be able to handle up to 200 alarm setups stored as event enrollment objects - system destination and actions individually configurable.

2.10 APPLICATION SPECIFIC CONTROLLER - TERMINAL UNIT CONTROLLERS

A. Provide one application controller for each terminal unit that adequately covers objects listed in object list for unit. Controllers to interface to building controller via LAN using specified protocol. Controllers to include on board flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. Application controllers to include universal inputs with 10-bit resolution that can accept thermistors, 0-5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller to also include support and modifiable programming for interface to intelligent room sensor with digital display (digital display to indicate set point only). Controller to also include binary outputs on board. For applications using variable speed parallel fans, provide a single analog output selectable for 0-10 V or 0-20 mA control signals. Application controller to include microprocessor driven flow sensor for use in pressure independent control logic. Terminal units controlled using pressure independent control algorithms and flow readings to be in CFM.

C. Program sequences stored on board application controller in EEPROM. No batteries needed to retain logic program. Program sequences executed by controller 10 times per second and capable of multiple PI loops for control of multiple devices. Provide programming of application controller completely modifiable in the field over installed specified protocol LANs or remotely via modem interface. Operator to program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller programmed using the same programming tool as Building Controller and as described in operator workstation Section.

D. Application controller to include support for intelligent room sensor. Display on room sensor programmable at application controller and include an operating mode and a field service mode. Button functions and display data programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence for specific display requirements for intelligent room sensor.

E. Provide duct temperature sensor at discharge of each terminal unit that is connected to controller for reporting back to operator workstation. Provide analog inputs for the duct temperatures.

2.11 INPUT/OUTPUT INTERFACE

A. Input/output points protected such that shorting of point to itself, to another point, or to ground will cause no damage to controller. Input and output points protected from voltage up to 24 V.

B. Binary inputs (BI or DI) allow monitoring of On/Off signals from remote devices. Binary inputs sense “dry contact” closure without external power (other than that provided by controller) being applied.

C. Pulse accumulation input objects accept up to 10 pulses per second for pulse accumulation.

D. Analog inputs (AI) allow monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD).

E. Binary outputs (BO or DO) provide for On/Off operation or pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers have three-position (On/Off/Auto) override switches and status lights. Outputs selectable for either normally open or normally closed operation.

F. Analog outputs (AO)provide a modulating signal for control of end devices. Outputs provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building controllers have status lights and two-position (AUTO/MANUAL) switch and adjustable potentiometer for manual override. Analog outputs not exhibit drift of greater than 0.4 percent of range per year.

G. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms run zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.12 POWER SUPPLIES AND LINE FILTERING

A. Control transformers UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits. Limit connected loads to 80 percent of rated capacity.

B. DC power supply output match output current and voltage requirements. Unit operates between 32 degrees F and 120 degrees F.

C. Line voltage units UL listed and CSA approved.

D. Power line filtering. Provide transient voltage and surge suppression for workstations and controllers.

2.13 CONTROL PANELS

A. Control Panels:
   1. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures to be NEMA 12 when installed in other than a clean environment. Outdoor enclosures must be NEMA 3R. Provide (hinged door) key-lock latch and removable subpanels. Single key common to field panels and subpanels. In existing campus or building settings, key lock to match existing keys.
   2. Interconnections between internal and face-mounted devices prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection individually identified per control drawings.
   3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.
   4. Provide laminated plastic nameplates for enclosures in any mechanical room or electrical room labeled with TCP number. Laminated plastic to be 1/8-inch thick sized appropriately to make label easy to read.

2.14 AUXILIARY CONTROL DEVICES

A. Temperature Instruments:
   1. Low-voltage or Line-voltage Thermostats: Bimetal-actuated, snap acting SPDT contact, enclosed, UL listed for electrical rating, exposed set point adjustment on cover with heat anticipator. Thermostat operates within 55 degrees F to 85 degrees F set point range, with 2 degrees F maximum differential.
   2. Room Temperature Sensors: Thermistor or platinum RTD type with accuracy of plus or minus 0.5 degrees F at 70 degrees F; operating range 30-120 degrees F; linear signal; single point sensing element in wall-mounted ventilated enclosure with insulating back plate if mounted on exterior wall; plug-in portable operators terminal port.
   3. Room Temperature Sensor: Thermistor or platinum RTD type with accuracy of plus or minus 0.5 degrees F at 70 degrees F; operating range 30-120 degrees F; linear signal; single point sensing element in wall-mounted ventilated enclosure with insulating back plate if mounted on exterior wall; push button for occupancy override; digital set point adjustment plus or minus 2 degrees F in both directions; LCD temperature display indicating set point only. set point adjustment to revert to building programmed standard temperature upon next building occupancy schedule change (user adjustable). Room temperature sensor may have integral space carbon dioxide sensor with minimum performance characteristics identified within this specification. Include integral occupancy sensor for public rooms and classrooms but not in offices.
   4. Averaging Duct Temperature Sensors: Thermistor or platinum RTD element with accuracy of plus or minus 0.5 degrees F at 32 degrees F, consisting of array of single point sensing elements, securely mounted in duct or plenum; operating range 20-120 degrees F; linear signal; 1-foot element per 2 SF of duct cross Sectional area. Use when duct is 9 SF or larger or where air is subject to temperature stratification.
   5. Probe Duct Temperature Sensors: Thermistor or platinum RTD element with accuracy of plus or minus 0.5 degrees F at 32 degrees F, consisting of single point sensing elements,

securely mounted in duct or plenum; operating range 20-120 degrees F; linear signal; 24-inch rigid probe. Use where duct is less than 9 SF cross Sectional area.

6. Outside Air Temperature Sensor: Thermistor or platinum RTD element with accuracy of plus or minus 0.5 degrees F at 32 degrees F; Range -58 to 120 degrees F, single element, linear, with weather and sun shield for exterior mounting.
7. Low Temperature Limit Thermostat: Minimum 20 foot capillary sensing element, triggering on low temperature as sensed by any 12-inch segment; snap acting, normally open contacts, manual reset, line voltage.
8. Liquid Immersion Temperature Sensor: Thermistor or platinum RTD element, with accuracy of plus or minus 0.5 degrees F at 32 degrees F, stainless steel well and assembly, range 30 to 250 degrees F.

B. Pressure Transmitters and Transducers:
1. Transducer have linear output signal; field adjustable zero and span. Sensing elements withstand continuous operating conditions of positive or negative pressure 50 percent greater than calibrated span without damage.
2. Differential Pressure Switch: set point adjustable with operating range of 0.5 to 12-inch WG for fans, and 5 to 30-feet WC for pumps. Switches UL listed; SPDT snap-acting; pilot duty rated (125 VA minimum); NEMA 1 enclosure; scale range and differential suitable for intended application.
3. Duct Static Differential Pressure Transducer: Operating range 0 to 5-inch WC for duct mounted transmitter; ceramic capacitive sensing element with probe securely mounted in duct; digital input terminal and push button to zero output. Accuracy plus or minus 1 percent of full scale; maximum response time 2 seconds.
4. Building Static Pressure Transducer: Operating range of -0.1 to 0.1-inch WC, linear signal. Sensing tubes located inside and outside building use shielding and/or surge tanks to minimize effects of wind. Accuracy plus or minus 1 percent of full scale.
5. Piping Pressure Transmitter: Operating range 0 to 50 PSIG, linear signal; stainless steel diaphragm; digital input terminal and push button to zero output. Accuracy plus or minus 1 percent of full scale.

C. Motorized Control Dampers:
1. Performance: Maximum leakage of 3 CFM/SF at 1-inch WG differential pressure, AMCA Class 1A, maximum pressure rating of 13-inch WG differential pressure, maximum velocity of 6,000 fpm, -72 degrees F to 275 degrees F temperature rating.
2. Multi-blade type, except where either dimension is less than 10-inch single blade may be used. Maximum blade length to be 48-inch.
3. Provide parallel blades for modulating mixing service and opposed blades for throttling service.
4. Blades to be interlocking; minimum 16 gauge galvanized steel; compression type edge seals and side seating stops. In copper, aluminum and stainless steel duct work, damper material matches duct work material.
5. Damper blades be reinforced, have continuous full length axle shafts, axle to axle linkage, and/or operating “jackshafts” as required to provide coordinated tracking of blades.
6. Bearings: Self-lubricating stainless steel sleeve or Celcon bearing.
7. Dampers over 25 SF in area to be in two or more sections, with interconnected blades.
8. Provide remote damper blade position status with binary input.
9. Tested in accordance with AMCA Standard No. 500.

D. Motorized Control Valves:
1. Body pressure rating and connection type construction conforms to pipe, fitting and valve schedules.
2. Fluid valve close-off ratings and spring ranges operate at maximum flows and maximum available pump heads scheduled without leakage.
3. Screwed ends except 2-1/2-inch and larger valves with flanged ends.
4. Modulating Control Valves:

a. 2-inch and smaller fail-in-place characterized ball valves; ANSI 250 body rating; bronze body and stainless steel trim.
b. 2-1/2-inch and larger cast iron ANSI Class 125, Other with guided equal percentage plug; PTFE packing.

5. Fluid three-way valves globe valves with linear plug with composition disc for tight shutoff.
6. Pressure drop equal to twice pressure drop through heat exchanger (load), 50 percent of pressure difference between supply and return mains, or 5 PSI, whichever is greater, except two-position valves be line size.
7. Bubble-tight line size butterfly valves acceptable on 2-1/2-inch lines and above for two-position action only; cast iron body; aluminum bronze disc; EPDM seat, 200 PSI wg
8. For modulating service that require valve sizes above 6-inch, butterfly or v-port ball valves are allowed.

E. Electric Damper/Valve Actuators:
1. Provide mechanical or electronic stall protection for each actuator.
2. Where indicated provide internal mechanical, spring-return mechanism or provide uninterruptible power supply (UPS). Non-spring-return actuators have external manual gear release to position damper/valve when actuator is not powered.
3. Proportional actuators accepts 0 to 10 VDC or 0 to 20 mA control signal and provide 2 to 10 VDC or 4 to 20 mA operating range.
4. Actuator sized for torque required plus 25 percent; UL or CSA listed; electronic current overload protection.
5. VAV Actuators: Actuators proportional 24 VAC actuators using a 4 to 20 mA range of control signals; stops automatically at end of travel; include permanently lubricated gear train.

F. Water Flow Meter:
1. Provide a Turbine Flow Meter (reference 23 05 19) complete with installation hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter hand-insertable up to 400 PSI. The flow meter to have two contra-rotating axial turbines, with electronic impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Wetted metal components nickel-plated brass. Provide 316L SS construction for hot water applications operating over 250 degrees F, and for any application in non-metallic pipe. The maximum operating temperature 280 degrees F, 300 degrees F peak. Each flow meter individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1 percent and traceable to NIST*. Manufacturer's certificate of calibration provided with each flow meter. Accuracy within plus or minus 0.5 percent of rate at the calibrated velocity, within plus or minus 1 percent of rate over a 10:1 turndown (3.0 to 30 ft/s) and within plus or minus 2 percent of rate over a 50:1 turndown (from 0.4 to 20 ft/s). The flow meter to include integral analog output(s), 4-20 mA, 0-10V, or 0-5V. Bi-directional meters to include an isolated contact closure output for direction. Flow meter covered by the manufacturer's two year warranty.
2. Retractable insertion vortex flow meter; accuracy plus 1.0 percent of full scale with 30 to 1 turndown capability; flow range 0.5 to 15 fps; analog output; 400 PSI operating pressure with 400 PSI ball valve; stainless steel shedder bar; rate/total display. Hydro-Flow (Emco) Model 3100.

G. Wall Mounted Space Carbon Dioxide Sensor:
1. Sensor to employ non-dispersive infrared technology. (N.D.I.R.)
2. Sensor Repeatability: Plus or minus 20 ppm. 0-2000.
3. Sensor Accuracy: Less than or equal to 75 ppm over 0-1500 ppm range.
4. Sensor Response Time: Less than 1 minute.
5. Sensor to employ reference channel design for long-term stability.
6. Sensor to have field selectable 0-10VDC, or 4-20mA outputs.
7. Sensor power requirement less than 3W.
8. Sensor Input Voltage: 20 to 30VAC/DC.

9. Sensor Operating Temperature Range: 0 degrees C to 50 degrees C.
10. Sensor to have models for wall mounting or duct mounting.
11. Sensor to provide at least a 1-year factory warranty from date of purchase.
12. Sensor to match cover in color and look to temperature sensor.
13. Sensor to have display.
14. Manufacturers:
    a. Telaire
    b. Vaisala
    c. Veris

H. Paddle Type Flow Switches: Paddle type switches (water service only) UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum) and have adjustable sensitivity with NEMA 1 enclosure.

I. Relays:
1. Control relays UL listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage be suitable for application.
2. Time delay relays UL listed solid-state plug-in type with adjustable time delay. Delay adjustable plus or minus 200 percent (minimum) from set point or as indicated. Contact rating, configuration, and coil voltage be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

J. Override Timers: Override timers spring-wound line voltage, UL Listed, with contact rating and configuration as required by application. Provide 0-to-6-hour calibrated dial unless otherwise specified. Timer suitable for flush mounting on control panel face and located on local control panels or where shown.

K. Current Transmitters:
1. AC current transmitters be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges 100 A full scale, with internal zero and span adjustment and plus or minus 1 percent full-scale accuracy at 500 ohm maximum burden.
2. Transmitter meets or exceeds ANSI/ISA S50.1 requirements and UL/CSA recognized.
3. Unit split-core type for clamp-on installation on existing wiring.

L. Current Transformers: AC current transformers UL/CSA recognized and completely encased (except for terminals) in approved plastic material; plus or minus 1 percent accuracy at 5 A full-scale.

M. Voltage Transmitters: AC voltage; self-powered single-loop (two-wire) type; 4 to 20 mA output with zero and span adjustment; UL/CSA recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1. Ranges include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with plus or minus 1 percent full-scale accuracy with 500 ohm maximum burden.

N. Voltage Transformers: AC voltage transformers UL/CSA recognized, 600 VAC rated; built-in fuse protection; suitable for ambient temperatures of 40 degrees F to 130 degrees F; plus or minus 0.5 percent accuracy at 24 VAC and a 5 VA load.

O. Power Monitors: Selectable rate pulse output for kWh reading; 4-20 mA output for kW reading; N.O. alarm contact; ability to operate with 5.0 amp current inputs or 0-0.33 volt inputs; plus 1.0 percent full-scale true RMS power accuracy; plus 0.5 Hz, voltage input range 120-600 V, and auto range select; NEMA 1 enclosure. Current transformers having a 0.5 percent FS accuracy, 600 VAC isolation voltage with 0-0.33 V output. If 0-5 A current transformers are provided, a three-phase disconnect/shorting switch assembly is required.

P. Overflow Switch: Insertion flow sensor, brass, impeller flow design with analog transmitter unit. Data Industrial Model 220BR.

Q. Emergency Stop Switch: Red, mushroom type, pull out to operate.

2.15 WIRING AND RACEWAYS

A. General: Provide copper wiring, plenum cable, and raceways as specified in applicable Sections of Division 26, Electrical.

B. Insulated wire to be copper conductors, UL labeled for 90 degrees C minimum service.

C. Field panels and controllers to be supplied by building emergency power system where systems being monitored or controlled are on emergency power.

D. Run control wiring as follows:
   1. Mechanical Rooms: In conduit.
   2. Exposed in Building Spaces: In conduit.
   3. Concealed in Building Walls and Ceilings: Plenum rated cable.
   4. Concealed in Building Ceilings: Plenum rated cable in cable tray.

E. Field and Subfield Panels: Voltage in panels not-to-exceed 120 volts.

F. Wiring for BAS systems communications buses two conductor minimum 18 gauge foil-shielded, stranded twisted pair cable rated at 300 VDC or more than 80 degrees C.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the Owners' representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until unsatisfactory conditions are resolved.

3.02 CONTROL SYSTEM CHECKOUT AND TESTING

A. Testing completed before Owner's representative is notified of system demonstration.

B. Calibrate and prepare for service of instruments, controls, and accessory equipment furnished under this specification.

C. Verify that control wiring is properly connected and free of shorts and ground faults.

D. Enable control systems and verify calibration and operation of input and output devices.

E. Verify that system operation adheres to sequences of operation.

F. Commissioning and Verification: In addition to commissioning requirements specified elsewhere, provide the following commissioning on the HVAC instrumentation and controls system:
   1. Control systems completely commissioned to ensure aspects of the system are operating as intended and at optimum tuning.
   2. Wiring connections verified and traced from field device to panel to ensure proper connections.
   3. Measured values verified by a hand held calibrated device to validate that value indicated by the control system is in fact the actual measured value.
   4. Loops properly tuned to obtain the desired control value. Each loop to be "upset" and put back in control to demonstrate its ability to stabilize quickly.
   5. Provide a final point-by-point report submitted that indicates the date of each verification, the results, and initialed on each page by the person performing the reading.

3.03 ACCEPTANCE TESTING AND TRAINING

A. Site Testing:
   1. Contractor provides personnel, equipment, instrumentation, and supplies necessary to perform testing. Owner or Owner's representative will witness and sign off on acceptance testing.

2. Contractor demonstrates compliance of completed control system with Contract Documents. Using approved test plan, physical and functional requirements of project demonstrated.

3.04 WIRING

A. Provide electrical wiring required to control systems specified in this Section. Control and interlock wiring complies with national, state and local electrical codes and Division 26, Electrical of this specification.

B. Power wiring required for building control panel(s) to be dedicated circuit(s).

C. Verify location of operator work station with Owner prior to installation.

D. NEC Class 1 (line voltage) wiring UL Listed in approved raceway according to NEC and Division 26, Electrical requirements.

E. Low-voltage wiring meets NEC Class 2 requirements. (Low-voltage power circuits subfused when required to meet Class 2 current limit.)

F. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for intended application.

G. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for purpose of interfacing (e.g., relays and transformers).

H. Where Class 2 wiring is run exposed, wiring run parallel along surface or perpendicular to it and tied at 10 foot intervals.

I. Where plenum cables are used without raceway, support from structural members. Do not support cables with ductwork, electrical raceways, piping, or ceiling suspension systems.

J. Make wire-to-device connections at terminal block or terminal strip. Make wire-to-wire connections at terminal block.

K. Maximum allowable voltage for control wiring 24 V. If only higher voltages are available, provide step-down transformers.

L. Wiring installed as continuous lengths, with no splices permitted between termination points.

M. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at penetrations.

N. Include one pull string in each raceway 1-inch or larger.

O. Control and status relays are to be located in designated enclosures. Enclosures include packaged equipment control panels unless they also contain Class 1 starters.

P. Install raceway to maintain a minimum clearance of 6-inches from high-temperature equipment (e.g., steam pipes or flues).

Q. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

R. Install insulated bushings on raceway ends and openings to enclosures. Seal top end of vertical raceways.

S. Flexible metal raceways and liquid-tight, flexible metal raceways not-to-exceed 3-feet in length and be supported at each end. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways to be used.

T. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway Sections joined with couplings. Terminations made with fittings at boxes.

U. Input and output terminations to be labeled at the controller to identify if they are AI, DI, AD, DO, and function (i.e. pump start, OM Sensor.)

3.05 COMMUNICATION WIRING

A. Follow manufacturer's installation recommendations for communication cabling.

B. Verify integrity of network following cable installation.

C. Communication wiring unspliced length when that length is commercially available; labeled to indicate origination and destination data.

D. Grounding of coaxial cable in accordance with NEC regulations article on “Communications Circuits, Cable, and Protector Grounding.”

3.06 INSTALLATION OF AUXILIARY CONTROL DEVICES

A. General:
   1. Install sensors and thermostats in accordance with manufacturer's recommendations.
   2. Room sensors and thermostats installed at 48-inches AFF to midline of sensor on concealed junction boxes properly supported by wall framing at the locations shown on the Drawings.
   3. Low-limit sensors used in mixing plenums installed in a serpentine manner horizontally across duct.
   4. Pipe-mounted temperature sensors installed in wells with heat-conducting fluid in thermal wells.
   5. Install outdoor air temperature sensors on north facing wall or screen, complete with sun shield at designated location.

B. Flow Switch: Use correct paddle for pipe diameter. Adjust flow switch in accordance with manufacturer's instructions.

C. Actuators:
   1. General:
      a. Mount and link control damper actuators according to manufacturer's instructions.
      b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
   2. Actuator Mounting for Damper and Valve Arrangements to Comply with the Following:
      a. Damper Actuators: Do not install in the air stream.
      b. Use a weather proof enclosure (clear and see through) if actuators are located outside.
      c. Damper or valve actuator ambient temperature not-to-exceed 122 degrees F through any combination of medium temperature or surrounding air. Provide appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation as necessary. Mount per manufacturer's recommendations.
      d. Actuator cords or conduit to incorporate a drip leg if condensation is possible. Do not allow water to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point to be avoided to prevent water from condensing in conduit and running into actuator.
      e. Damper mounting arrangements to comply with the following:
         1) Furnish and install damper channel supports and sheet metal collars.
         2) Jack shafting of damper Sections not allowed.
         3) Multi-Section dampers arranged so that each damper Section operates individually. Provide one electronic actuator direct shaft mounted per Section.
      f. Size damper Sections based on actuator manufacturers specific recommendations for face velocity, differential pressure and damper type. In general: Damper Section not-to-exceed 24 ft-sq. with face velocity 1500 FPM.
      g. Multiple Section dampers of two or more arranged to allow actuators to be direct shaft mounted on the outside of the duct.
      h. Multiple Section dampers of three or more Sections wide arranged with a 3-sided vertical channel (8-inch wide by 6-inch deep) within the duct or fan housing and between adjacent damper Sections. Vertical channel anchored at the top and bottom to the fan housing or building structure for support. Connect sides of each damper

frame to the channels. Holes in the channel to allow damper drive blade shafts to pass through channel for direct shaft mounting of actuators. Face open side of channel downstream of the airflow, except for exhaust air dampers.

i. Multiple Section dampers to be mounted flush within a wall or housing opening to receive either vertical channel supports as described above or sheet metal standout collars. Sheet metal collars (12-inch minimum) to bring each damper Section out of the wall to allow direct shaft mounting of the actuator on the side of the collar.

D. Control Valve:
   1. Valves installed in accordance with manufacturer's recommendations.
   2. Slip-stem control valves installed so that stem position is not more than 60 degrees from vertical up position. Ball type control valves installed with stem in horizontal position.
   3. Control valves accessible and serviceable.
   4. Install isolation valves so that control valve may be serviced without draining supply/return side piping system. Install unions at connections to screw-type control valves.
   5. Valve Sizing for Water Coil:
      a. On/Off Control Valves: Line size.
      b. Modulating Control Valve Body Size may be reduced at most two pipe sizes from the line size or not less than 1/2 the pipe size. BAS contractor to size all water coil control valves for the application as follows:
         1) Booster-heat valves sized not-to-exceed 4-9 PSI differential pressure. Size valve for 50 percent Valve Authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.
         2) Primary valves sized not-to-exceed 5-15 PSI differential pressure. Size valve for 50 percent Valve Authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.
         3) Butterfly valves sized for modulating service at 60-70 degree rotation. Design velocity 12-feet per second or less when used with standard EPDM seats.
      c. Valve Mounting Arrangements to Comply with the Following:
         1) Provide unions on all ports of two-way and three-way valves.
         2) Install three-way equal percentage Characterized Control valves in a mixing configuration with the “A” port piped to the coil.
         3) Install 2-1/2-inch and above, Three-Way globe valves, as manufactured for mixing or diverting service to the coil.

E. Control Damper:
   1. Dampers installed in accordance with manufacturer's instructions. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
   2. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.07 SMOKE DETECTION (FOR PROJECTS WITH A FIRE ALARM SYSTEM)

A. Smoke detector furnished and powered/wired under Division 28, Electronic Safety and Security. Coordinate with fire alarm equipment supplier. Installation of duct smoke detector housing and sampling tube under Division 23, HVAC.

B. Install smoke detectors in return air systems greater than 2000 CFM.

3.08 SEQUENCES OF OPERATION AND POINTS LISTS

A. Where local energy code dictates certain sequences (such as night setback, night flush, pressure and temperature reset, terminal unit sequences, etc.), the sequences are not necessarily repeated in the documents. It is not the intent of this specification or documentation to reiterate the energy code. Provide all energy code mandated sequences and document in sequence of operations submittals at no additional cost to the Owner. Provide all required points to achieve the appropriate sequences.

B. Points lists and sequences of operation will be developed by the controls installer by working directly with the district. No points lists or sequences of operations are provided in this specification.

C. When any type of air distribution equipment is not in operation, control devices to remain in their "off" positions. "Off" positions may differ from the "normal" (meaning failed) position. Except as specified otherwise, "off" and "normal" positions of control devices to be as follows:

Device	"Off" Position	"Normal" Position
Hydronic Water Coil Valves	closed	open
Outside Air Damper	closed	closed
Return Air Damper	open	open
Exhaust/Relief Air Damper	closed	closed
Fire and Smoke Dampers	closed	open

1. Variable Frequency Drives: For a VFD dependent on an external input for its output setting (e.g., the VFD gets “Frequency” as an input), loss of that external input to result in the VFD holding its last value. If the VFD is running its own PID loop and the external input to the VFD is a setpoint (e.g. duct static pressure setpoint), the VFD to hold the last setpoint. If the VFD loses its process variable (e.g. duct static pressure), the VFD to go to its minimum speed setting.

D. Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials to be centered on the associated setpoint. All modulating feedback control loops to include the capability of having proportional, integral, and derivative action. Unless the loop is specified “proportional only” or “P+I”, Contractor to apply appropriate elements of integral and derivative gain to each control loop to result in stable operation, minimum settling time and maintain the primary variable within the specified maximum allowable variance.

E. Provide a real time clock and schedule controller with sufficient scheduling capability to schedule all required controllers and sequences. Schedule functionality may reside in a controller. If a controller is used, document scheduling functionality including names and types on controller points list submittal. Set up initial schedules in coordination with Owner.

F. Scheduling Terminology: When air handlers are scheduled throughout the day, the following defines the terminology used:
1. Occupied Period: Period of time when the building is in use and occupied. Confirm schedule with Owner. Exclude all national holidays. Generally systems will be fully operational throughout this period and ventilation air to be continuously introduced. Space temperature setpoints will generally be in the “normal” range of 68 degrees to 78 degrees F.
2. Unoccupied period: Period of time when the building or zone is not in use and unoccupied. Ventilation air not to be introduced.
3. Preoccupancy Period: Time prior to the Occupied period when the systems are returning the space temperatures from setback to “normal” or occupied setpoints (warm-up and cool-down). Ventilation air shall not be introduced unless outside air conditions permit free-cooling or to support a pre-occupancy purge sequence. Time period to be determined by an optimum start strategy unless otherwise specified.
4. Setback Period: Setback will typically start with the end of the occupied period and end with the start of the preoccupancy period, however it shall be provided with its own schedule. Generally systems will be off except to maintain a “setback” temperature, economization may be enabled to maintain “setback” cooling setpoint when applicable.

G. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the BAS start commands to be staggered by 5 second (adj.) intervals to minimize inrush current.

H. Wherever a value is indicated as adjustable (adj.), it shall be modifiable, with the proper password level. For these points, it is unacceptable to have to modify programming statements to change the setpoint.

I. When a power failure is detected in any phase, the BAS start commands to be retracted immediately from all electrically powered units served by the failed power source. If the associated controller is powered by normal or emergency power, it may monitor its own power source as an indication of power status. If the controller is powered by uninterruptible power supply (UPS), or if it is not capable of monitoring its own power for use in sequences, provide at least one voltage monitor (three phase when applicable) per building. When the BAS detects that normal or emergency power has been restored, all equipment for which the BAS start command had been retracted to be automatically restarted in an orderly manner on staggered 5 second intervals to minimize inrush current.

J. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, employ one of the following methods:
   1. Determine a fixed reset schedule to result in stable operation and maintain the primary variable within the specified maximum allowable variance.
   2. Use a floating reset algorithm which increments the secondary variable setpoint (setpoint of control loop being reset) on a periodic basis to maintain primary variable setpoint. The recalculation time and reset increment to be chosen to maintain the primary variable within the specified maximum allowable variance.
   3. Primary variable to control the devices directly using a PID feedback control loop without resetting the secondary variable. However, the control devices to still modulate as necessary to maintain upper and lower limits on the secondary variable. Proportional band, integral gain, and derivative term to be selected to maintain the primary variable within the specified maximum allowable tolerance while minimizing overshoot and settling time. Gain prior approval for implementing this method of reset.

K. Where a supply air temperature or duct pressure setpoint is specified to be reset by the space temperature of the zones calling for the most cooling/heating, emply the following method:
   1. Use a floating reset algorithm which increments the secondary variable (e.g., supply air temperature or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g., space temperature) setpoint. The reset increment to be determined by the quantity of “need heat” or “need cool” requests from individual SCU's. A SCU's “need heat” virtual point to activate whenever the zone's space temperature falls below the currently applicable (occupied or unoccupied) heating setpoint throttling range. A SCU's “need cool” virtual point to activate whenever the zone's space temperature rises above the currently applicable (occupied, unoccupied, or economy) cooling setpoint throttling range. The recalculation time and reset increment to be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. Reset range maximum and minimum values to limit the setpoint range.

L. Where a supply air temperature, duct pressure, or differential water pressure setpoint is specified to be reset by valve or damper position of the zone or zones calling for the most cooling/heating, the following method to be employed:
   1. A floating reset algorithm to be used which increments the secondary variable (e.g., supply air temperature, pipe or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g., cooling valve, heating valve, damper position) setpoint of85 percent open. The reset increment to be calculated based on the average position of the quantity of the worst (most open valve/damper) zone(s) as specified. The recalculation time, reset increment and control device position influence to be chosen to maintain the primal variable within the specified maximum allowable variance while overshoot and settling time. The BAS analog output value to be acceptable as indicating the position of the control device.
   2. Alternatively to continuously calculating the average of the quantity of worst valve/damper positions, a method similar to the one described above may be employed whereby the “need heat” or “need cool” virtual point to increment by one unit each time a zone's

valve/damper position rises to greater than 95 percent. The quantity of “need heat” or “need cool” points to then be the basis for reset.

M. Where “prove operation” of a device (generally controlled by a digital output) is indicated in the sequence, it shall require that the BAS, after an adjustable time delay after the device is commanded to operate (feedback delay), confirm that the device is operational via the status input. If the status point does not confirm operation after the time delay or anytime thereafter for an adjustable time delay (debounce delay) while the device is commanded to run, an alarm to be enunciated audibly. Upon failure, run command to be removed and the device to be locked out until the alarm is manually acknowledged unless specified otherwise.

N. BAS to provide for adjustable maximum rates of change for increasing and decreasing output from the following analog output points:
   1. Speed control of variable speed drives
   2. Control Reset Loop
   3. Valve Travel Limit

O. Wherever a value is indicated to be dependent on another value (i.e., setpoint plus 5 degrees F) BAS to use that equation to determine the value. Simply providing a virtual point that the operator must set is unacceptable. In this case three virtual points to be provided. One to store the parameter (5 degrees F), one to store the setpoint, and one to store the value which is the result of the equation.

END OF SECTION

SECTION 23 0913
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Variable Frequency Drive
   2. Protection Circuits
   3. Display and Control Interface
   4. Adjustments

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Current edition of IEEE Standard 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   2. Current edition of UL 508, Industrial Control Equipment.
   3. Current edition of NEMA ICS 7, Industrial Control and Systems: Adjustable-Speed Drives; National Electrical Manufacturers Association, latest edition.
   4. Current edition of IEC 16800 parts 1, 2 and 3
   5. Current edition of NEC 430.120, Adjustable-Speed Drive Systems.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product Data: Indicate voltage, controller size, ratings and size of switching and overcurrent protection devices, short circuit ratings, dimensions, weights and enclosure detains.
   2. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and name plate legends.
   3. Test Reports: Subject VFD to preliminary functional test, and final test at 104 degrees F, at full rated load. Indicate field test and inspection procedures and test results.
   4. Manufacturer's Instructions: Include installation instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
   5. Maintenance Data: Include routine preventive maintenance schedule.
   6. Compliance to IEEE 519, harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
      a. Manufacturer to provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5 percent. VFD's to include a minimum of 5 percent impedance reactors, no exceptions.
   7. Rated input: Maximum electric load rating in amperes.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet following:
   1. Qualifications:
      a. Provide VFDs and options UL listed as a complete assembly. Base VFD UL listed for 100 KAIC without the need for input fuses.

b. CE Mark: VFD to meet product standard EN 61800-3 for the First Environment restricted level. (RFI/EMI Filter specification.)
c. Entire VFD enclosure, including the bypass, seismically certified and labeled in accordance with the International Building Code:
    1) VFD manufacturer to provide Seismic Certification and Installation requirements at time of submittal.
    2) Seismic importance factor of 1.5 rating is required, and based upon actual shake test data as defined by International Code Council AC-156.
    3) Seismic ratings based upon calculations alone are not acceptable. Certification of Seismic rating must be based on testing done in all three axis of motion by a certified lab.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB
B. Danfoss
C. Emerson
D. General Electric
E. Square D
F. Yaskawa
G. Or approved equivalent.

2.02 VARIABLE FREQENCY DRIVE

A. Description:
    1. Variable Frequency Drive: Solid state, with Pulse Width Modulated (PWM) output waveform in a UL listed enclosure (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by manufacturer. Employ full wave rectifier, AC or DC Line Reactor, capacitors, and Insulated Gate Bipolar Transistors (IGBTs) as output switching device.
    2. Enclosure: UL rated and UL listed as a plenum rated VFD with NEMA 1 enclosure (indoors), NEMA 3R (outdoors), NEMA 12 (for indoor dusty locations), NEMA 8 (hazardous, Class I, Div I) and NEMA 9 (Class II, Div I). Manufacturers standard enamel.
    3. Drive manufacturer to supply the drive and necessary options specified. VFD's that are manufactured by a third party and "brand labeled" are not acceptable. Provide VFD's installed on this project from the same manufacturer.

B. Operating Requirements:
    1. Rated Input Voltage: VAC as scheduled on drawings, plus or minus 10 percent, 3 phase, 48 to 63 Hz.
    2. Rated Output Voltage: 0 to input voltage, 3 phase, 0 to 120 Hz.
    3. Fundamental Power Factor: Between 1.0 and 0.97, lagging, over entire range of operating speed and load.
    4. Minimum Efficiency at Full Speed and Full Load: 97 percent or better.
    5. Volts Per Hertz Adjustment: Plus or minus 10 percent.
    6. Current Adjustment: 60 to 110 percent or rated.
    7. Acceleration Rate Adjustment: 0.5 to 300 seconds.
    8. Deceleration Rate Adjustment: 1 to 300 seconds.
    9. Transient protection against normal transients and surges in incoming power line.

10. Environmental Conditions: 32 degrees F to 104 degrees F at 4kHz switching frequency, 0 to 3000-feet above sea level, less than 95 percent RH, noncondensing. Circuit boards to have conformal coating.
11. Seismic Testing: Tested to ICC AS-156. Submit certificate of compliance.

C. Standard Features:
1. VFD's to have the same customer interface, including digital display, and keypad, regardless of horsepower rating. Provide removable keypad, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFD's.
2. Fault Mode on Loss of Input:
   a. Display fault.
   b. Run at programmable preset speed as selected by user.
3. Utilize English digital display (code numbers are not acceptable). Digital Display: Three configurable lines of LCD display, backlit, adjustable contrast. Setup parameters, indications, faults, warnings, status indicators and other information in words without use of manual or cross reference table.
4. Automatic restart after overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. Programmable number of restart attempts, trial time, and time between reset attempts.
5. Capable of starting into rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
6. Automatic extended power loss ride-through circuit.
7. Customer terminal strip isolated from line and ground.
8. Keypad Hand-Off-Auto switch. When in "Off" VFD will be stopped. When in "Auto" VFD will start via external contact closure and its speed will be controlled via external speed reference. When in “Hand” VFD will be controlled via keypad up and down arrows.
9. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.
10. Input Line Reactor: Five percent impedance AC or DC, to reduce harmonics to power line and to add protection from AC line transients.
11. Output filters for VFD's located more than 350 conductor feet from motor served.
12. Optimized for 4 kHz carrier frequency to reduce motor noise.
13. Bypass Controller:
   a. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD isolation fuses.
   b. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the “Off” position before either enclosure may be accessed.
   c. VFD and bypass package to have a UL listed short circuit current rating (SCCR) of 100,000 amps and indicated on the UL data label.
   d. Drive Isolation Fuses: Provide fast acting fuses, exclusive to the VFD, to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. Bypass designs, which have no such fuses will not be accepted.
   e. The system (VFD and Bypass) tolerated voltage window to allow the system to operate from a line of +30 percent, -35 percent nominal voltage range. The system to incorporate circuitry that will allow the drive or bypass contactor to remain “sealed in” over this voltage tolerance at a minimum.
   f. The bypass to maintain positive contactor control throughout the voltage tolerance window of nominal voltage +30 percent, -35 percent. Designs that will not allow input single phase operation in the VFD mode are not acceptable.
   g. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power

indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.

h. Bypass system will NOT depend on the VFD for bypass operation. Bypass system designed for stand alone operation and completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair/replacement. Serial communications to remain functional even with the VFD removed.

i. Serial communications: Provide bypass capable of being monitored and / or controlled via serial communications. On-board communications protocols to include ModBus, Johnson Controls N2, Siemens Building Technologies FLN (P1), LonWorks and BACnet MS/TP.

j. Bypass control to include a programmable time delay for bypass start and keypad indication that this time delay is in process. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. Time delay field programmable from 0 - 120 seconds.

k. Provide user selectable text to be displayed on the keypad when an external safety opens. Example text display indications include “FireStat," “FreezStat,” “Over Pressure” and “Low Suction”. User to have ability to determine which of the up to four customer safety contacts is open over the serial communications connection.

14. Disconnecting Means: Include door interlocked, UL 508C listed circuit breaker or fused disconnect switch.
15. Control circuit transformer with fused primary and secondary circuits.
16. Motor overload protection: Fused disconnects for each motor when serving multiple motors from one drive.
17. Input current rating of the VFD to be no more than 3 percent greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120.
18. VFD to provide a programmable loss-of-load (broken belt/broken coupling) Form-C relay output. Provide programmable drive to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus.

2.03 PROTECTION CIRCUITS

A. Overload Rating: 110 percent of its variable torque current rating for 1 minute every 10 minutes at 104 degrees F, and 140 percent of its H torque current rating for 2 seconds every 15 seconds.

B. 350 percent instantaneous overcurrent trip.

C. 130 percent to 65 percent over and under voltage trip.

D. Over temperature trip at 115 degrees F.

E. Short circuit protection, either running or at start, for phase to phase and phase to ground faults, phase rotation insensitive.

F. Adaptable Electronic Motor Overload (I2t).

G. EMI/RFI Filters: VFD's to include EMI/RFI filters. Onboard filters to allow the entire VFD assembly to be CE Marked and the VFD to meet product standard EN 61800-3 for the First Environment restricted. No Exceptions.

H. Orderly Shutdown: In event of any of above conditions, shutdown drive safely without component failure.

2.04 DISPLAY AND CONTROL INTERFACE

A. Serial Communications:

1. VFD to have an EIA-485 port as standard. Standard protocols: Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet MS/TP. The use of third party gateways and multiplexers is not acceptable. Protocols “certified” by the governing authority (i.e. BTL Listing for BACnet).

B. Display operating information at VFD and provide separate interface signal for Building Automation System (BAS) via communications port to display and control following:
   1. Frequency Output - Hz
   2. Output voltage - Volts
   3. Current - Amps
   4. Speed - RPM
   5. Runtime - Hours
   6. System Fault
   7. Input Speed Setpoint - RPM
   8. On/Off Control Signal
   9. Calculated Motor Power - percentage or kW
   10. kWh meter

2.05 ADJUSTMENTS

A. Three programmable critical frequency lockout ranges.

B. Two programmable analog inputs. Analog inputs to include filters programmable from 0.01 to 10 seconds to remove any oscillation in input signal.

C. Six programmable digital inputs for maximum flexibility in interfacing with external devices.

D. Three remote contacts for fault including on/off status, fault and future configuration.

E. Two programmable analog outputs proportional to frequency, motor speed, output voltage, output current, or scalable parameter selected by Owner.

F. Run permissive circuit: Provide a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, input contact closure, time-clock control, or serial communications), the VFD to provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) to close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Provide a minimum of two separate safety interlock inputs. When any safety is opened, the motor commanded to coast to stop and the damper commanded to close.

G. The VFD control to include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates.

H. The VFD to include a fireman's override input. Mode to override other inputs (analog/digital, serial communication, and keypad commands), except customer defined safety run interlocks, and force the motor to run at a preset speed or in a separate PID mode.

PART 3- EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturers installation instructions. Maintain manufacturer's and NEC service clearances.

B. Install on strut support stand and brace for seismic.

C. Select and install overload heater elements in motor controllers to match installed motor characteristics.

D. Power wiring completed by the contractor, to NEC code 430.122 wiring requirements based on the VFD input current.

3.02 START-UP

A. Factory certified service representative to supervise start-up in accordance with manufacturer's instructions.

B. Make final adjustments to assure proper operation of load system. Demonstrate final set-up and programming to Owner.

C. Test unit in modes of operation and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

END OF SECTION

SECTION 23 1123

FACILITY FUEL - NATURAL GAS PIPING AND SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Fuel Pipe and Pipe Fittings
   2. Natural Gas Valves
   3. Gas Earthquake Valve
   4. Natural Gas Pressure Regulators
   5. Gas Solenoid Valves
   6. Flexible Pipe Connectors - Gas Piping (CSA Listed)
   7. Natural Gas Convenience Outlets

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
   1. Division 26, Electrical requirements for grounding fuel piping systems.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements apply to this Section.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Natural Gas Valves:
   1. Apollo
   2. Jenkins Bros.
   3. Lunkenheimer Co.
   4. Nibco
   5. Watts
   6. Or approved equivalent.

B. Gas Earthquake Valve:
   1. California Valve
   2. QuakeMaster
   3. Or approved equivalent.

C. Natural Gas Pressure Regulators:
   1. Maxitrol
   2. Equimeter
   3. Or approved equivalent.

D. Gas Solenoid Valves:
   1. ASCO Red Hat
   2. Or approved equivalent.

E. Natural Gas Convenience Outlets:
   1. MB Sturgis
   2. Or approved equivalent.

F. As specified in Articles below, or approved equivalent.

2.02 FUEL PIPE AND PIPE FITTINGS

A. Steel Pipe (Above Grade Installation):
   1. 2-inches and Smaller: Schedule 40, A53 black steel pipe and threaded black malleable threaded fittings.
   2. 2-1/2-inches and Larger: Schedule 40, A53 black pipe with Schedule 40 butt weld fittings.
   3. ASTM A53, electric-resistance welded Type E Grade B, black, Schedule 40 pipe, manufactured for threaded pipe connections.

B. Fittings for Steel Pipe (Above Grade Installations):
   1. General: Mark fittings, unions, and other products recognized as regularly available products in accordance with MSS SP-25. Marking on products of small size or shape may be omitted from sequence allowed by MSS SP-25, except for manufacturer's name or trademark.
   2. Threaded Fittings: Conforming to ANSI B2.1, ASTM A47, 150 PSI rating, except where otherwise specified or prevailing codes or requirements dictate use of 300 PSI ratings. Fittings to be fabricated from standard malleable iron with dimensions conforming to ANSI B16.3.
   3. Welded Fittings: Wrought carbon steel fittings, ASTM A234, ANSI B16.9, B16.28. Butt-welding type unless otherwise indicated to be socket welding type.
   4. Flanges: Carbon steel conforming to ASTM A105, ANSI B16.5, and factory forged in USA. Flanges which have been machined, remade, painted, or are non-domestic origin are not acceptable. Provide raised or full face ends wherever indicated or required.
   5. Flange Gaskets: Gaskets to be constructed from Buna-N (Nitrile) elastomeric materials.
   6. Flange Hardware: Bolting materials to be corrosion resistant carbon steel bolts and hex nuts conforming to ASTM A307. Provide bolting materials used in containment sumps below grade applications, stainless steel bolts and hex nuts conforming to ASTM A453. Threads and dimensions to be in accordance with ANSI B1.1 and B18.2.
   7. Unions: Conform to ANSI B16.39, ASTM A47 and fabricated from malleable iron with bronze-to-iron ground joints rated at 150 percent design operating pressure. Threads to conform to ANSI B2.1.
   8. Threaded Pipe Plugs: Conforming to ANSI B16.14.
   9. Thread Lubricant: Meet or exceed CGA ratings and compliant with Federal Specification TT-S-1732, manufactured compatible with fuel oil.

C. Corrugated Stainless Steel Tubing (CSST) (Above Grade Installations): 3/8- to 1-inch ID sizes only.
   1. Tubing: Corrugated stainless steel tubing manufactured of Type 304 stainless steel with yellow polyethylene jacketing and complying with ANSI/CSA LC-1 Standards.
   2. Fittings: Brass mechanical type fittings utilizing a retainer ring, slide ring, silicone O-ring and high temperature sealing gasket.
   3. Termination Plates and Brackets: Provide premanufactured termination plates and brackets of same manufacturer as pipe (CSST).
   4. Valves: Ball valves, brass mechanical type utilizing retainer rings, slide rings, silicone O-rings and high temperature sealing gasket. Comply with ANSI/ASME B16.33.
   5. Manifolds: Field fabricated Schedule 40, A53 black steel pipe nipples and black malleable threaded fittings.
   6. Manufacturer: Tru-Flex, Pro-Flex, Gastite, or approved equivalent.

2.03 NATURAL GAS VALVES

A. 2-inches and Smaller: MSS SP-110 ball valves constructed in compliance with ASME B16.33. UL listed, FM approved, two-piece construction, threaded, bronze or brass body, full port,

chrome plated brass ball, blowout-proof stem design, 125 PSI WOG working pressure. Watts FBV-3C, Nibco FP-600A, Apollo 64, or Jenkins 201J.

B. 2-1/2-inches and Larger: 100 to 125 PSI rated, all bronze or iron body/bronze trimmed plug cock type, square head or tee/lever handle operation. CSA listed.

C. Manufacturers: Apollo, Jenkins Bros., Lunkenheimer Co. Div. of Conval Corp., Nibco, Watts, or approved equivalent.

2.04 GAS EARTHQUAKE VALVE

A. Gas line valve providing automatic shutoff in case of earthquake. UL listed, CSA certified and FM approved. The valve or system to actuate shutoff means within 5 seconds when subjected to horizontal, sinusoidal oscillation having a peak acceleration of 0.3G (2.94 m/s2) and period of 0.4 seconds. Sensing means of valve or system not to actuate shutoff means when subjected for 5 seconds to horizontal, sinusoidal oscillations having:
   1. A peak acceleration of 0.4G (3.94 m/s2) with a period of 0.1 second,
   2. A peak acceleration of 0.08G (0.078 m/s2) with a period of 0.4 second, and
   3. A peak acceleration of 0.08G (0.078 m/s2) with a period of 1.0 second.

B. Valve requires manual reset. Provide with needed spare parts to allow resetting after having been tripped. Valve to be same size as line size installed.

2.05 NATURAL GAS PRESSURE REGULATORS

A. Natural Gas: Diaphragm and spring actuated type, with ventless or vented relief feature. Construction, pressure range and venting features suitable for intended service. Regulator to meet code and serving utility requirements. Pipe vented type to atmosphere in approved location. Manufacturers: Maxitrol, Equimeter, or approved equivalent.

2.06 GAS SOLENOID VALVES

A. General: Solenoid bodies will be brass construction with NPT ports. The vales will be "normally closed" and pilot operated or direct acting depending on application.

B. Electrical: 125V/1ph/60Hz

C. Internal Construction: Type 304 and Type 316 internal parts, elastomeric seals and lubricants as appropriate for gas service.

D. Basis-of-Design: ASCO Red Hat, Series 8210, and Series 8030. Specific model numbers scheduled in drawings.

2.07 FLEXIBLE PIPE CONNECTORS - GAS PIPING (CSA LISTED)

A. Inner Hose: Type 304 stainless steel.

B. Exterior Sleeve: Braided, Type 304 stainless steel.

C. Pressure Rating: 175 PSI at 70 degrees F up to 4-inch pipe.

D. Joint: Threaded carbon steel.

E. Maximum Offset: 3/4-inch on each side of installed center line.

F. Basis of Design: Hyspan CSAMN.

2.08 NATURAL GAS CONVENIENCE OUTLETS

A. Outlet designed for connection only when gas valve is in closed position.

B. Capacity of up to 60,000 BTU for natural gas.

C. Temperature Range: -40 degrees F to 240 degrees F.

D. Pressure Rating: To 26 PSIG and tested to 350 PSIG.

E. ANSI Z21.90 certification.

PART 3 - EXECUTION

3.01 INSPECTION

A. General: Examine areas and conditions under which fuel systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 IDENTIFICATION

A. Install mechanical identification in accordance with Section 23 05 53, Identification for HVAC Piping and Equipment.

3.03 FUEL PIPING INSTALLATION

A. General: Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each route with a minimum of joints and couplings, but with adequate and accessible unions or flanges for disassembly, maintenance, and replacement of valves and equipment. Reduce sizes by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance. Comply with ANSI B31.9 Code for Pressure Piping. Provide shutoff valves, pressure regulators and unions at connections to gas-fired equipment. Provide dirt legs at low points.

B. Installed piping not to interfere with maintenance of equipment, opening of doors or other moving parts nor be directly above or near any portion of electrical equipment.

C. Support piping such that connected equipment does not bear weight of piping.

D. Adequately support vertical lines at their bases or by suitable hanger placed in horizontal line near riser or, preferably, by base fitting set on a pedestal.

E. Piping Through Roof: Coordinate roof penetrations prior to installation of piping. Coordinate location with roof structure and roof mounted equipment.

F. Ream steel pipes after cutting to full bore. Remove foreign matter from inside of pipe before installing. Keep installed piping free from dirt and scale and protect open ends from foreign matter. Use temporary plugs or other approved methods for opening and closure.

G. Remake or replace defective, leaking, or otherwise unsatisfactory joints or material. Peening, caulking, or doping of piping is not permitted.

H. Threading: Thread steel pipe in accordance with ANSI B21.1 with standard right hand threads. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or proper pipe joint tape where recommended by pipe/fitting manufacturer on male threads at each joint and tighten joint to leave not more than three threads exposed.

I. Sealants: Use sealants on metal fuel piping threads which are chemically resistant to fuel. Use sealants sparingly and apply only to male threads of metal joints.

J. Maintain electrically continuous piping system; provide grounding jumper where required to maintain continuity. Provide grounding connection; install per requirements of Division 26, Electrical.

K. Install dirt legs in gas piping where indicated and where required by code or regulation. Do not rest dirt leg on surface of roof, floor or deck.

L. Support gas piping above roof on preformed pipe stands. Guide pipes with clamp one size larger than pipe. Provide supports at intervals per code manufacturer, and details and at each change in direction. Wood blocks are not approved supports.

M. Gas Regulator Vent Piping: Provide Schedule 40, A53 black steel pipe and threaded black malleable threaded fittings for vent piping. Paint piping exposed to weather with primer and one coat of Safety Yellow Rustoleum.

N. Piping: Paint piping exposed to weather with primer and one coat of Safety Yellow Rustoleum.

3.04 INSTALLATION OF VALVES

A. Gas Cocks: Provide at connection to gas train for each gas-fired equipment item, and on risers and branches where indicated.

B. Locate gas valves where easily accessible and protected from possible damage.

C. Pressure Regulating Valves: Install as required at gas-fired appliances; comply with utility/code requirements. Pipe atmospheric vent to outdoors, full size outlet with 90 degree elbow downturn. Install gas shutoff valve upstream of each pressure regulating valve. Install in accordance with manufacturer's instructions to prevent freezing.

D. Install earthquake valves per manufacturer's installation requirements. In a multi-building campus setting, provide a gas earthquake valve at each building gas point of entry whether shown on drawings or not.

3.05 EQUIPMENT CONNECTIONS

A. General: Connect gas piping to each gas-fired equipment item, with drip leg and shutoff gas cock. Comply with equipment manufacturer's instructions. Flexible connections where required per ASCE 7-10 or shown on Drawings.

3.06 PIPING TESTS

A. Test natural gas piping in accordance with applicable mechanical code requirements, ANSI B31.2, and local utility requirements.

END OF SECTION

SECTION 23 2113
HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Hydronic Water Piping, Above Ground
   2. Hydronic Water Piping, Buried
   3. Equipment Drains and Overflows
   4. Unions
   5. Refrigerant Piping

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Welding Certificates: Copies of certificates for welding procedures and personnel.
   2. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
      a. Test procedures used.
      b. Test results that comply with requirements.
      c. Failed test results and corrective action taken to achieve requirements.
   3. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at project site.
   4. Buried piping manufacturer to submit thrust block (chilled water) layout and details including anchorage and seismic calculations.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Installer Qualifications: Company specializing in performing work of the type specified in this Section, with documented experience.
   2. Welder Qualifications: Certify in accordance with ASME (BPV IX).
   3. ASME Compliance: Comply with ASME B31.9 "Building Services Piping" for materials, products, and installation. Provide safety valves and pressure vessels with the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 01.
   4. Refrigerant Piping:
      a. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX "Welding and Brazing Qualifications."
      b. ASHRAE Standard: Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
      c. ASME Standard: comply with ASME B31.5, "Refrigeration Piping."
      d. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical" or UL 429 "Electrically Operated Valves."

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. As specified in Articles below.

B. Or approved equivalent.

2.02 HYDRONIC WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A 53M, Schedule 40, black, Type E (electric resistance welded), Grade B.
   1. Fittings: ASME B16.3, malleable iron or ASTM A 234/A 234M, wrought steel welding type.
   2. Wrought Cast and Forged Steel Flanges and Flanged Fittings: ASME B16.5 including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      a. Material Group: 1.1.
      b. End Connections: Butt welding.
      c. Facings: Raised face.
   3. Joints: Threaded or AWS D1.1 welded.

B. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), drawn.
   1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
   2. Joints: Solder, lead free ASTM B32, HB alloy (95-5 tin antimony), or tin and silver.
   3. Joints: Brazed, AWS A5.8, Classification BAg-1 (silver). Pipes 2-1/2-inches or larger or piping routed over food preparation centers, food serving facilities, food storage areas, computer rooms, telecommunications rooms, and electrical rooms.

2.03 HYDRONIC WATER PIPING, BURIED

A. Underground Hydronic Water Piping Systems:
   1. Ricwil
   2. Thermacor
   3. Rovanco.
   4. Perma-Pipe
   5. Or approved equivalent.

B. Steel Pipe: ASTM A 53/A 53M, Schedule 40, black, Grade B, ERW (Type E) or seamless (Type S).
   1. Fittings: ASTM A 234/A 234M, wrought steel welding type.
   2. Weld Fittings:
      a. Changes in direction made with weld fittings.
      b. Where tee branches are smaller than the mains they join, weld-o-lets may be used.
      c. Provide weld fittings long radius and the same wall thickness as adjacent piping.
   3. Joints: Welded in accordance with AWS D1.1.
   4. Insulation: Polyurethane foam either spray applied or high pressure injected with one shot into the annular space between carrier pipe and jacket. Insulation rigid, 90-95 percent closed cell polyurethane with a 2.0 to 3.0 pounds per cubic foot density and coefficient of thermal conductivity (K-Factor) of 0.14 and conforming to ASTM C-591. Maximum operating temperature not-to-exceed 250 Degrees F.
   5. Jacketing Material: Provide either extruded white polyvinyl chloride, consisting of clean, virgin NSF approved Class 12454-B PVC compound, conforming to ASTM D-1784, Type 1, Grade 1 or high density polyethylene (HDPE). Provide PVC jacket with a wall thickness in mils equal to ten times the nominal jacket diameter and not less than 60 mils. HDPE to have a minimum wall thickness of 125 mils for jacket sizes equal to or less than 12-inch or 150 mils for jacket sizes greater than 12-inch to 24-inch and used for all jacketing larger than 16-inch. No FRP, HDUP, or tape jacket allowed.
   6. Provide jacketing for fittings, valves, etc. of the same material as for piping.

7. Expansion Loop and Ells:
   a. Expansion loops or expansion elbows furnished and enclosed in the same type of casing as those furnished for the standard Section of the piping system.
   b. Size to permit the inner pipe or pipes to move without damage to the insulation material.
   c. Expansion loops or expansion elbows prefabricated and shipped to the job site in as few pieces as possible (manufacturer's recommendations to govern).
   d. Inner pipe loops and expansion bends cold sprung in the field as required.
   e. Provide calculations as part of submittals.
8. Moisture Barrier End Seals: Factory applied, sealed to the jacket and carrier pipe. End seals certified as having passed a 20-foot head pressure test. Provide end seals with high temperature mastic completely sealing the exposed end of the insulation. Field applied end seals installed at any field cut to the piping before continuing with the installation.

C. Copper Tube: ASTM B 88 (ASTM B 88M), Type K (A) annealed. Copper piping to have ends cut square for socket brazing. Provide straight Sections of factory insulated pipe of 20-feet in length and having 6-inches of exposed pipe at each end for field joint fabrication. Field joining of piping to utilize approved methods of silver soldering or brazing with alloys melting at or above 1100 degrees F; 50-50 tin-lead solder is not acceptable.
   1. Fittings: ASME B16.22, wrought copper.
   2. Joints: Solder, lead free, ASTM B32, HB alloy (95-5 tin-antimony), or tin and silver.
   3. Insulation: Polyurethane foam either spray applied or injected with one shot into the annular space between carrier pipe and jacket, and bonded to both. Insulation rigid, 90-95 percent closed cell polyurethane with a 2.0 to 3.0 pounds per cubic foot density and coefficient of thermal conductivity (K-factor) of 0.14 and conforming to ASTM C-591. Maximum operating temperature of urethane not-to-exceed 250 degrees F.
   4. Jacketing Material: Provide either extruded white polyvinyl chloride, consisting of clean, virgin NSF approved Class 12454-B PVC compound, conforming to ASTM D-1784, Type 1, Grade 1 or high density polyethylene (HDPE). Provide PVC jacket with a wall thickness in mils equal to ten times the nominal jacket diameter and not less than 60 mils. HDPE to have a minimum wall thickness of 125 mils for jacket sizes equal to or less than 12-inch or 150 mils for jacket sizes greater than 12-inch to 24-inch and used for all jacketing larger than 16-inch. No FRP, HDUP or tape jacket allowed.
      a. Provide jacketing for fittings, valves, etc. of same material as for piping.
   5. Expansion Loops and Ells:
      a. Expansion loops or expansion elbows furnished and enclosed in the same type of casing as those furnished for the standard Section of the piping system.
      b. Size to permit the inner pipe or pipes to move without damage to the insulation material.
      c. All expansion loops or expansion elbows prefabricated and shipped to the job site in as few pieces as possible (manufacturer's recommendations govern).
   6. Provide inner pipe loops and expansion bends cold sprung in the field as required.
   7. Moisture Barrier End Seals: Factory applied, sealed to the jacket and carrier pipe. End seals certified as having passed a 20-foot head pressure test. Provide end seals with high temperature mastic completely sealing the exposed end of the insulation. Field applied end seals installed at any field cut to the piping before continuing with the installation.

2.04 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), drawn.
   1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
   2. Joints: Solder, lead free, ASTM B 32, HB alloy (95-5 tin-antimony), or tin and silver.

2.05 UNIONS

A. Unions for Pipe 2-inches and Under:
   1. Ferrous Piping: 150 PSIG malleable iron, threaded, ASME B16.39.
   2. Copper Pipe: Bronze, soldered joints, ASME B16.22.

B. Dielectric Connections: Provide brass nipple fitting with threaded ends. Dielectric unions are not allowed.

2.06 REFRIGERANT PIPING

A. Piping:
   1. Copper Tube: ASTM B 280, Type ACR, drawn-temper tube, clean, dry and capped.
      a. Fittings: ASME B16.22 wrought copper.
      b. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy (15 percent Silver).
   2. Copper Tube to 5/8-inch OD: ASTM B280. Tube ACR, annealed-temper copper tube, clean, dry and capped.
      a. Fittings: ASME B16.26 cast copper.
      b. Joints: Flared.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.02 BURIED PIPING INSTALLATION

A. Install in accordance with Drawings, specifications, and manufacturer's installation instructions. Provide a field service instructor on site to train the Contractor in all phases of installation.

B. Underground Systems: Buried in a trench of not less than 2-feet deeper than the top of the pipe and not less than 18-inches wider than the combined O.D. of all piping systems. A minimum thickness of 24-inches of compacted backfill over the top of the pipe is required. System installation must meet H-20 highway loading.

C. Trench bottom to have a minimum of 6-inch of sand, pea gravel, or specified backfill material, as approved by the engineer, as a cushion for the piping. Field cutting of the pipe performed in accordance with the manufacturer's installation instructions.

D. Provide thrust blocking, anchor plates, and concrete.

E. Cast a concrete block over anchor plates as recommended by manufacturer. Block to sit on undisturbed trench sidewalls and/or the bottom of the trench. Concrete block to be at least the length as recommended by manufacturer and extend a minimum distance as recommended by manufacturer beyond the top and bottom of anchor plate

F. Pressure test buried piping per Field Quality Control article below.

G. Field Service: Provided by a certified manufacturer's representative or company field service technician. The technician will be available at the job to check unloading, storing, and handling of pipe, joint installation, pressure testing and backfilling techniques.

H. Provide identification and tracer wire. Section 23 0553, Identification for HVAC Piping, Ductwork and Equipment.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install hydronic water piping to ASME B31.9 requirements.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and to avoid interference with use of space.

E. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

F. Sleeve pipe passing through partitions, walls and floors allowing adequate space for pipe insulation.

G. Slope piping at 0.2 percent upward in direction of flow and arrange to drain at low points.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

I. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

J. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

K. Anchor piping for proper direction of expansion and contraction.

L. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement Section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

M. Pipe Hangers and Supports:
   1. Install in accordance with Division 23, HVAC, Hangers and Supports.
   2. Install hangers to provide minimum1/2-inch space between finished covering and adjacent work.
   3. Place hangers within 12-inches of each horizontal elbow.
   4. Use hangers with 1-1/2-inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
   8. Provide copper plated hangers and supports for copper piping.
   9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

N. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

O. Provide access where valves and fittings are not exposed.

P. Use eccentric reducers to maintain top of pipe level.

Q. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

R. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

S. Refrigerant Piping:
   1. Install systems in accordance with ASHRAE Standard 15.
   2. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
   3. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
   4. Flood piping system with nitrogen when brazing.
   5. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

6. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
7. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
8. Fully charge completed system with refrigerant after testing.

3.04 FIELD QUALITY CONTROL

A. Leave joints, including welds, uninsulated and exposed for examination during test.

B. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

C. Flush system with clean water. Clean strainers.

D. Isolate equipment from piping. If a valve is used to isolate equipment, provide closure capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

E. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

F. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
   3. Check expansion tanks to determine that they are not air bound and that system is full of water.
   4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure not-to-exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied for at least four hours, examine piping, joints and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
   6. Prepare written report of testing.

G. Refrigerant Piping:
   1. Test refrigeration system in accordance with ASME B31.5.
   2. Pressure test system with dry nitrogen to 200 PSI. Perform final tests at 27-inches vacuum and 200 PSI using electronic leak detector. Test to no leakage.

3.05 FLUSHING AND CLEANING OF PIPING SYSTEMS

A. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the piping systems in service. Provide temporary connections for cleaning, purging, and circulating fluids through the piping system.

B. Use temporary strainers and temporary pumps that can create fluid velocities up to 10 feet per second to flush and clean the piping systems. Do not use Owner's permanent strainers to trap debris during pipe flushing operations. Fit the temporary construction strainers with a line size blowoff valve.

C. When constructing minor piping modifications or additions, verify with Owner if the Owner's pumps and strainers can be used for flushing and chemical cleaning operations. When the flushing and cleaning operations are complete, insure the strainer baskets and screens installed int he piping systems permanent strainers are replaced with clean elements. Keep temporary strainers in service until the equipment has been tested, then replace straining element with a new strainer and clean and deliver the old straining elements to Owner. Fit the Owner's strainers with a line size blowoff valve.

D. Install bypass piping or hoses at the supply and return piping connections at heat exchangers, chillers, cooling towers, pumps, and cooling coils, etc., to prevent debris from being caught or causing damage to equipment which will be connected to the piping system.

E. Circulate a chemical cleaner in hydronic water piping systems to remove mill scale, grease, oil, and silt. Cleaner to be selected by chemical treatment vendor on project. Circulate for 48 hours, flush system and replace with clean water. Dispose of chemical solution in accordance with local codes. The hydronic water system should then be treated with chemicals and inhibitors to be selected by chemical treatment vendor on project. When the chemical cleaning is complete, remove, clean, and reinstall all permanent screens. Notify Owner so that the reinstallation of clean strainer screens may be witnessed.

3.06 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

END OF SECTION

SECTION 23 2116
HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Diaphragm Type Expansion Tanks
   2. Air Vents
   3. Centrifugal Air Separator
   4. Coalescing Type Air and Dirt Separator
   5. Liquid Flow Switches
   6. Instrument Probe Fittings
   7. Strainers
   8. Relief Valves

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 01 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
   2. Certificates: Inspection certificates for pressure vessels from Authority Having Jurisdiction (AHJ).
   3. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
   4. Project Record Documents: Record actual locations of flow controls.
      a. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this Section, with minimum three years of documented experience.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing Sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Diaphragm Type Expansion Tanks:
1. Amtrol Inc.
2. ITT Bell & Gossett
3. Taco, Inc.
4. Armstrong
5. Wessels
6. Aurora
7. Or approved equivalent.

B. Air Vents:
1. Armstrong International, Inc.
2. ITT Bell & Gossett.
3. Taco, Inc.
4. Hoffman
5. Amtrol
6. Metraflex
7. Or approved equivalent.

C. Coalescing Type Air and Dirt Separator:
1. Spirovent VDT
2. Taco
3. Bell and Gossett
4. Caleffi
5. Aurora
6. Or approved equivalent.

D. Liquid Flow Switches:
1. McDonnell & Miller
2. Dwyer
3. Or approved equivalent.

E. Instrument Probe Fittings:
1. Pete's Plug
2. Or approved equivalent.

F. Strainers:
1. Armstrong International
2. Mueller
3. Keckley
4. Hoffman
5. Wheatly
6. Victaulic
7. Or approved equivalent.

G. Relief Valves:
1. Armstrong
2. ITT Bell & Gossett
3. Taco
4. Amtrol
5. Kunkle
6. Or approved equivalent.

2.02 DIAPHRAGM-TYPE EXPANSION TANKS

A. Construction: Welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); supplied with National Board Form U-1, rated for working pressure of 125 PSI, with flexible EPDM diaphragm sealed into tank, and steel support stand.

B. Accessories: Pressure gauge and air-charging fitting, tank drain.

2.03 AIR VENTS

A. Manual Type: Short vertical Sections of pipe to form air chamber, with 1/8-inch brass needle valve at top of chamber.

B. Automatic Float Type:Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.04 COALESCING TYPE AIR AND DIRT SEPARATOR

A. Description: Fabricated steel tank stamped in accordance with Section VIII of ASME Boiler and Pressure Vessel Code for Unfired Vessels, stamped for 150 PSI, with tangential inlet and outlet connections, integral copper bundle of Spirotubes to fill internal area and venting chamber with float actuated automatic air vent. Separator shell include valved side tap to flush floating dirt for bleed. Internal medium to force dirt and sediment to fall from flow path to collection chamber for blow down.

2.05 LIQUID FLOW SWITCHES

A. Description: Brass for wetted parts with packless construction, paddle with removable segments for pipe size and flow velocity, vapor proof electrical compartment for switches mounted on cold hydronic piping systems, switches for 115V, 60 Hz, 1-phase with 7.4A rating.

2.06 INSTRUMENT PROBE FITTINGS

A. Brass or stainless steel body and cap, high pressure rated, valve material neoprene, Nordal or Viton to suit temperature range, 1/4-inch or 1/2-inch NPT tailpiece.

2.07 STRAINERS

A. Size 2-inches and Under: Screwed brass or iron body for 175 PSI working pressure, Y pattern with 1/16-inch stainless steel perforated screen.

B. Size 2-1/2-inches and Larger: Flanged or grooved and above: iron body for 175 PSI working pressure, Y pattern with 1/16 stainless steel perforated screen.

C. Basket Pattern: Flanged iron body for 175 PSI working pressure, basket pattern with 1/8-inch stainless steel perforated screen, clamped or bolted cover.

2.08 RELIEF VALVES

A. Size and capacity as selected by installer for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.

B. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210F, and pressure relief at 125 PSI.

C. Pressure Relief Valves: Bronze body, test lever, ASME rated. Provide pressure relief as indicated on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Where large air quantities can accumulate, provide enlarged air collection standpipes.

C. Provide valved drain and hose connection on strainer blow down connection.

D. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.

E. Support pump fittings with floor mounted pipe and flange supports. Provide vibration isolation, same as pump, to avoid short circuiting.

F. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

G. Pipe relief valve outlet to nearest floor drain.

H. Where one line vents several relief valves, make cross Sectional area equal to sum of individual vent areas.

I. Air Separators: Install in pump suction lines and as indicated. Run piping to expansion tank with 1/4-inch per foot (2 percent) upward slope towards tank. Install drain valve on units 2-inches and over.

J. Expansion Tanks: Install tank in accordance with manufacturer's instructions. Charge tank with air per manufacturer's instructions. Prior to making connection from the tank to the system, check the air charge. Valve is to be opened to the system when it is determined that the air pressure is equal to the minimum system pressure at the tank location.

K. Liquid Flow Switches: Install on inlet to water chiller as indicated. Install in horizontal pipe with switch mounted in tee on top of pipe with minimum of 24-inches of straight pipe with no fitting both upstream and downstream of switch. Remove segments of paddle to fit in accordance with manufacturer's instructions.

L. Water Relief Valves: Install as indicated, and on expansion tanks, hot water tanks and pressure vessels. Pipe discharge to floor drain. Comply with ASME Boiler and Pressure Vessel Code.

M. Pressure Reducing Valves: Install as indicated, and in accordance with manufacturer's instructions with 3 valve bypass.

N. Test Plugs: Install where indicated and in accordance with the manufacturer's recommendations.

O. Water Filters: Install per manufacturer's recommendations where shown. After system is accepted by Owner, provide 1 set of filters for each filter station.

P. Differential Pressure Regulating Valve: Install per manufacturer's recommendations where shown on Drawings.

3.02 AIR VENTS

A. Automatic: Furnish and install automatic air vents in mechanical equipment rooms and outdoors only. Install at high points of system piping, at heat transfer coils, and elsewhere as required for system air venting. Vents: 3/4-inch with 1/2-inch IPS drain piping to the nearest floor drain or other approved location. Provide a ball valve and union ahead of all automatic air vents. Do not install above ceilings or locations where discharge may occur and cause damage.

B. Manual Vents: Provide at high points of system piping, at heat transfer coils, and elsewhere as required for system venting where automatic air vents are not to be installed. Provide 10-inch length of 1/4-inch copper tube with 180 degree bend down to discharge into hand-held bucket.

END OF SECTION

SECTION 23 2123
HYDRONIC PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. General Pump Requirements
   2. End Suction Base Mounted Pumps

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association, current edition.
   2. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association, current edition.
   3. NFPA 70 - National Electrical Code; National Fire Protection Association, current edition.
   4. UL 778 - Standard for Motor-Operated Water Pumps; Underwriters Laboratories Inc., current edition.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
   2. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
   3. Millwright's Certificate: Certify that base mounted pumps have been aligned.
   4. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirement.

B. In addition, meet the following:
   1. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.
   2. Alignment: Base mounted pumps will be aligned by qualified millwright.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.08 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Mechanical Seals: One mechanical seal for each pump.

1.10 PERFORMANCE REQUIREMENTS

A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Armstrong Pumps Inc.

B. ITT Bell & Gossett.

C. Taco Pumps

D. Paco Pumps

E. Wilo

F. Weil

G. Grundfos

H. Xylem

I. Or approved equivalent.

2.02 GENERAL PUMP REQUIREMENTS

A. Pump Units: Factory assembled and tested.

B. Motors: Include built-in, thermal-overload protection and grease-lubricated ball bearings. Select each motor to be nonoverloading over full range of pump performance curve.

C. Motors Indicated to Be Energy Efficient: Minimum efficiency as indicated according to IEEE 112, Test Method B. Provide premium efficiency motors according to IEEE 112, Test Method.

2.03 END-SUCTION BASE MOUNTED PUMPS

A. Type: Horizontal shaft, base-mounted, centrifugal, flexible-coupled, end-suction, single-stage, bronze-fitted, back-pull-out, direct connected, radially or horizontally split casing, for 175 psi maximum working pressure.

B. Casing: Cast iron, with suction and discharge gauge ports at low point of volute, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge, integral feet or other means on volute to support weight of casing and attached piping. Casing to allow removal and replacement of impeller without disconnecting piping.

C. Impeller: ASTM B584 cast bronze, fully enclosed, statically and dynamically balanced, closed, overhung, single suction, keyed to shaft, and secured by locking cap screw.

D. Wear Rings: Replaceable, bronze casing ring.

E. Bearings: Oil lubricated roller or ball bearings.

F. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

G. Seal: Mechanical seal, 225 degrees F, maximum continuous operating temperature with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.

H. Base, Coupling and Guard: Pumps mounted on cast-iron base and directly connected through heavy duty flexible coupling to horizontal motor. Provide OSHA coupling guard mounted between pump and motor and attached firmly to base.

I. Drive: Flexible coupling with coupling guard.

J. Performance Electrical Characteristics:
   1. As Scheduled. 1750 RPM motors unless specified otherwise.
   2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions according to HI 1.1-1.5 "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation.

B. Provide access space around pumps for service including removing motors, impellers, couplings, and accessories. Provide no less than minimum space recommended by manufacturer.

C. Decrease from line size with long radius reducing elbows or reducers. Eccentric reducers where necessary to prevent air entrapment. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4-inches and over. Provide vibration isolation to insure there is no short circuiting of pump vibration isolator. Refer to Section 23 0548.

D. Unless indicated otherwise on drawings, provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve and shut off valve on pump discharge. Triple duty valves not allowed.

E. Provide air cock and drain connection on horizontal pump casings.

F. Provide drains for bases and seals, piped to and discharging into floor drains.

G. Install base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.

H. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2-inches (19 to 38 mm) between pump base and foundation for grouting.

I. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

J. Lubricate pumps before start-up.

3.02 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting them on foundations, after grout has been set and foundation bolts have been tightened, and after piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23, HVAC Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

F. Install pressure gauges and temperature gauges on pump suction and discharge. Install at integral pressure-gauge tappings where provided.

G. Install temperature and pressure-gauge connector plugs in suction and discharge piping around each pump.

H. Install electrical connections for power, controls, and devices.

I. Electrical power and control wiring and connections are specified in Division 26, Electrical Sections.

J. Ground equipment.

K. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:
   1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
   2. Review data in maintenance manuals. Reference Division 01, General Requirements.
   3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.05 EXAMINATION

A. Examine equipment foundations and anchor -bolt locations for compliance with requirements for installation.
   1. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
   2. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

END OF SECTION

SECTION 23 2200
STEAM AND CONDENSATE PIPING AND PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Low Pressure Steam Piping (15 PSIG Maximum)
   2. Low Pressure Steam Condensate Piping
   3. Unions, Flanges, and Couplings
   4. Gate Valves

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
   1. AWS A5.8/A5.8M Specification for Filler Metals for Brazing and Braze Welding, American Welding Society, current edition.
   2. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry Inc., current edition.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product Data:
      a. Provide for manufactured products and assemblies required for this project.
      b. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
      c. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
      d. Include electrical characteristics and connection requirements.
   2. Manufacturer's Installation Instructions: Indicate application, selection, and hookup configuration. Include pipe and accessory elevations.
   3. Operation and Maintenance Data: Include installation instructions, servicing requirements, and recommended spare parts lists.
   4. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
   5. Welders Certificate: Include welders certification of compliance with ASME (BPV IX).
   6. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Installer Qualifications: Company specializing in performing the work of this Section, with minimum five years of documented experience.
   2. Welder Qualifications: Certified in accordance with ASME (BPV IX) current edition.

1.06 WARRANTY

A. Warranty of materials and workmanship as outlined in Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 SYSTEM DESCRIPTION

A. When more than one piping system material is selected, ensure systems components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

B. Use unions and flanges downstream of valves and at equipment or apparatus connections. Use dielectric unions where joining dissimilar materials. Do not use direct welded or threaded connections.

C. Provide pipe hangers and supports in accordance with current edition of ASME B31.9 unless indicated otherwise.

D. Use gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

E. Use gate valves for throttling, bypass, or manual flow control services.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing Sections of the work, and isolating parts of completed system.

1.09 EXTRA MATERIALS

A. See Division 01, General Requirements, Product Requirements, for additional provisions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Low Pressure Steam Piping (15 PSIG Maximum):
   1. Taylor Forge and Pipe Works
   2. Or approved equivalent.

B. Low Pressure Steam Condensate Piping:
   1. Taylor Forge and Pipe Works
   2. Or approved equivalent.

C. Unions, Flanges and Couplings:
   1. Same manufacturer as pipe
   2. Or approved equivalent.

D. Gate Valves:
   1. Conbraco Industries
   2. Nibco Inc.
   3. Milwaukee Valve company
   4. Or approved equivalent.

2.02 LOW PRESSURE STEAM PIPING (15 PSIG MAXIMUM)

A. Steel Pipe: ASTM A 53/A 53M, Schedule 40, black.
   1. Fittings: ASME B16.3 malleable iron Class 150, ASME B16.5 flanged or ASTM A 234/A 234M wrought steel.
   2. Joints: Threaded, or AWS D1.1 welded.

B. Steel Pipe Sizes 12-inch and Over: ASTM A 53/A 53M, 0.375-inch wall, black.
   1. Fittings: ASTM A 234/A 234M wrought steel.

2. Joints: Welded in accordance with AWS D1.1.

2.03 LOW PRESSURE STEAM CONDENSATE PIPING

A. Steel Pipe: ASTM A 53/A 53M, Schedule 80, black.
   1. Fittings: ASME B16.3 malleable iron Class 150, or ASTM A 234/A 234M wrought steel.
   2. Joints: Threaded, or AWS D1.1 welded.

B. Steel Pipe Sizes 12-inch and Over: ASTM A 53/A 53M, 0.375-inch wall, black.
   1. Fittings: ASTM A 234/A 234M wrought steel.
   2. Joints: Welded in accordance with AWS D1.1.

2.04 UNIONS, FLANGES, AND COUPLINGS

A. Unions for Pipe 2-inches and Under:
   1. Ferrous Piping: 150 PSIG malleable iron, threaded.

B. Flanges for Pipe Over 2-inches:
   1. Ferrous Piping: 150 PSIG forged steel, slip-on.
   2. Gaskets: 1/16-inch thick preformed non-asbestos graphite fiber.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, water impervious isolation barrier.

2.05 GATE VALVES

A. Up To and Including 2-inches:
   1. Bronze body, bronze trim, screwed bonnet, rising stem, handwheel, inside screw with solid wedge disc, threaded ends.

B. Over 2-inches:
   1. Iron body, bronze trim, bolted bonnet, rising, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.

E. Install in accordance with manufacturer's instructions.

F. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

G. Install piping to conserve building space and avoid interference with use of space.

H. Sleeve pipe passing through partitions, walls, and floors.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

J. Pipe expansion, in general, is to be absorbed in bends, swing joints, expansion loops, and offsets. Provide piping mains, branches and runouts installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Provide stresses within allowable limits of ANSI B31.1 for pressure piping. Provide vertical piping for steam and steam condensate with expansion joints as indicated. Packing not required for expansion joints. Installer to select materials and pressure/temperature ratings to suit intended service. Select packless expansion joints to provide 150 percent absorption capacity of calculated maximum piping expansion between anchors. Connections to have ends to match piping system application. Expansion Joints for Steam Piping with pre-fabricated stainless steel bellows with integral guide rods.

K. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9

2. Support horizontal piping as scheduled.
3. Place hangers within 12-inches of each horizontal elbow.
4. Use hangers with 1-1/2-inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

L. Provide clearance for installation of insulation and access to valves and fittings.

M. Provide access where valves and fittings are not exposed.

N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

O. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Reference Section 09 90 00.

3.02 LOW PRESSURE STEAM PIPING (15 PSIG MAXIMUM) INSTALLATION

A. Slope steam piping 1/2-inch in 10-feet in direction of flow. Use eccentric reducers to maintain bottom of pipe level.

B. Install steam and steam condensate piping and specialties in accordance with ASME B31.9.

3.03 LOW PRESSURE STEAM CONDENSATE PIPING INSTALLATION

A. Slope condensate piping 1/2-inch in 10 feet.

B. Install steam and steam condensate piping and specialties in accordance with ASME B31.9.

3.04 UNIONS, FLANGES, AND COUPLINGS INSTALLATION

A. Install steam and steam condensate piping and specialties in accordance with ASME B31.9.

3.05 GATE VALVES INSTALLATION

A. Valves to be line size unless noted otherwise.

B. Install valves with stems upright or horizontal, not inverted.

END OF SECTION

SECTION 23 2500
HVAC WATER TREATMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Chemicals

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Qualifications: Firms regularly engaged in manufacture of components of types and sizes required.
   2. Installer Qualifications: An experienced installer who is an authorized representative of the chemical treatment manufacturer for both installation and maintenance of chemical treatment equipment required for this Project.
   3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 PERFORMANCE REQUIREMENTS

A. Maintain water quality for HVAC systems that controls corrosion and build-up of scale and biological growth for maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.

B. Base chemical treatment performance requirements on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction. Consult equipment manufacturer prior to acceptance of values noted below.
   1. Closed System: Maintain system essentially free of scale, corrosion, and fouling to sustain the following water characteristics:
      a. pH: Maintain a value within 9.0 to 10.5.
      b. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
      c. Boron: Maintain a value within 100 to 200 ppm.
      d. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
      e. Soluble Copper: Maintain a maximum value of 0.20 ppm.
      f. TDS: Maintain a maximum value of 10ppm.
      g. Ammonia: Maintain a maximum value of 20 ppm.
      h. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
      i. Microbiological Limits:
         1) Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.

2) Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
3) Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
4) Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
5) Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

2. Passivation for Galvanized Steel (for the first 60 days of operation):
   a. pH: Maintain a value within 7 to 8.
   b. Calcium Carbonate Hardness: Maintain a value within 100 to 300 ppm.
   c. Calcium Carbonate Alkalinity: Maintain a value within 100 to 300 ppm.

1.08 MAINTENANCE

A. Scope of Service: Provide chemicals and service program for maintaining optimum conditions in the circulating water for inhibiting corrosion, scale, and organic growths in the heating and chilled water 2-pipe hydronic system and equipment. Services and chemicals provided for a period of one year from date of Substantial Completion, including the following:
   1. Initial water analysis and recommendations.
   2. Startup assistance.
   3. Periodic field service and consultation.
   4. Customer report charts and log sheets.
   5. Laboratory technical assistance.
   6. Analyses and reports of chemical items concerning safety and compliance with government regulations.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Aqua-Chem, Inc.; Tom Hubbard, district contact

2.02 CHEMICALS

A. Furnish chemicals recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment.

B. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.

C. Biocide: Chlorine release agents or microbiocides.

D. Closed-Loop, Water Piping Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.

PART 3 - EXECUTION

3.01 WATER ANALYSIS

A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article.

3.02 INSTALLATION

A. Install treatment equipment level and plumb. Provide power to all system devices.

B. Add cleaning chemicals as recommended by manufacturer.

C. To prevent dirt and solids from lodging the coils, before adding cleaning chemical to the closed system, air handling coils and fan coil units to be isolated by closing the inlet and outlet valves and opening the bypass valves Do not valve in or operate system pumps until after system has been cleaned.

D. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the by-pass valves. Also, clean strainers.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23, HVAC Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.04 FIELD QUALITY CONTROL

A. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
   1. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.

3.05 ADJUSTING

A. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare certified test report for each required water performance characteristic. Where applicable, comply with ASTM D 3370 and the following standards:
   1. Silica: ASTM D 859.
   2. Steam System: ASTM D 1066.
   3. Acidity and Alkalinity: ASTM D 1067.
   4. Iron: ASTM D 1068.
   5. Water Hardness: ASTM D 1126.

B. Occupancy Adjustments: Within 12 months of Substantial Completion, perform two separate water analyses to prove that automatic chemical feed systems are maintaining water quality within performance requirements specified in this Section. Perform analyses at least 60 days apart. Submit written reports of water analysis.

3.06 GAUGE ADJUSTING AND CLEANING

A. Adjust faces of meters and gauges to proper angle for best visibility.

B. Clean windows of meters and gauges and factory finished surfaces. Replace cracked or broken windows, repair scratched or marred surfaces with manufacturer's touch-up paint.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.
   1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

B. Review manufacturer's safety data sheets for handling of chemicals.

C. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service.

D. Schedule at least four hours of training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION

SECTION 23 3100
HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Ductwork, Joints and Fittings
   2. Type I, Grease Hood Ductwork
   3. Type II, Vapor Hood Ductwork
   4. Laundry Clothes Dryer Vent
   5. Insulated Flexible Duct
   6. Drain Pans
   7. Ductwork Joint Sealers and Sealants

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
   1. Section 23 05 29, Hangers and Supports for HVAC Piping, Ductwork and Equipment.
   2. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Welding Certificates
   2. Field Quality Control Reports

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. NFPA Compliance:
      a. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
      b. NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
   2. Comply with NFPA 96, Ventilation Control and Fire Protection of Commercial Cooking Operations, Ch. 3, Duct System for range hood ducts, unless otherwise indicated.
   3. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Provide sheet metal materials free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
   4. If required, provide ductwork pressure testing per Section 23 05 93, Testing, Adjusting and Balancing for HVAC.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Duct design is generally diagrammatic and is not meant to be scaled. Major changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout

modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Ductwork, Joints, and Fittings:
   1. Ductmate
   2. Lindab Inc
   3. Nexus Inc
   4. SEMCO
   5. United McGill Corporation
   6. Ward Industries
   7. Or approved equivalent

B. Type 1, Grease Hood Ductwork:
   1. CaptiveAire
   2. Metal-Fab
   3. Security Chimneys International
   4. Selkirk
   5. Or approved equivalent.

C. Type II, Vapor Hood Ductwork:
   1. Semco
   2. United McGill Corporation
   3. Or approved equivalent.

D. Laundry Clothes Dryer Vent:
   1. Manufacturer not applicable.

E. Insulated Flexible Duct:
   1. ATCO
   2. Flexmaster
   3. J.P. Lamborn Co.
   4. Hart and Cooley
   5. Or approved equivalent

F. Drain Pans:
   1. Not applicable.

G. Ductwork Joint Sealers and Sealants
   1. Ductmate
   2. Durodyne
   3. Hardcast
   4. United McGill Corporation
   5. Vulkem
   6. Or approved equivalent

2.02 DUCTWORK, JOINTS AND FITTINGS

A. Materials:
   1. Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, lock-forming quality, ASTM A 653/A 653M FS Type B, with G90/Z275 coating. Ducts to have mill phosphatized finish for surfaces exposed to view.
   2. Stainless Steel: Fabricated in accordance with ASTM A167 and A480.

B. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
   1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.

2. Deflection: Duct systems not-to-exceed deflection limits according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible.
3. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

C. Formed-On Flanges: construct according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Figure 1-4, using corner, bolt, cleat, and gasket details.
1. Duct Size: Maximum 30-inches wide and up to 2-inch wg pressure class.
2. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
3. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19-inches and larger and 0.0359-inch thick or less, with more than 10 SF of nonbraced panel area unless ducts are lined.

D. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of material specified in this Section according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible.
1. Ducts up to 20-inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21- to 72-inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Ducts Larger than 72-inches in Diameter: Companion angle flanged joints per SMACNA HVAC Duct Construction Standards-Metal and Flexible, Figure 3-2.
4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

E. 90-Degree Tees and laterals and Conical Tees: Fabricate to comply with SMACNA's HVAC Duct Construction Standards-Metal and Flexible, with metal thicknesses specified for longitudinal-seam straight ducts.

F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows to be 1.5 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's HVAC Duct Construction Standards-Metal and flexible, unless otherwise indicated.
2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg (minus 500 to plus 500 Pa):
   a. Ducts 3- to 36-inches in Diameter: 0.034-inch .
3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
   a. Ducts 3- to 26-inches in Diameter: 0.034-inch.
4. 90-Degree, two-piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
5. Round Elbows
   a. 8-inches and Less in Diameter: Fabricate die-formed elbows for 45 and 90-degree elbows and pleated elbows for 30, 45, 60 and 90 degrees only. Fabricate nonstandard bend-angle configurations or non-standard diameter elbows with gored construction.
   b. 9 through 14-inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60 and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
   c. Larger than 14-inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
6. Die-Formed Elbows for Sizes through 8-inches in Diameter and Pressures 0.040-inch thick with two-piece welded construction.
7. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.

8. Pleated Elbows for Sizes through 14-inches in Diameter and Pressures through 10-inch wg (2500 Pa): 0.022-inch.

H. Flat Oval Duct
1. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with circumference equal to the perimeter of a given size of flat-oval duct.
2. Flat Oval, Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's HVAC Duct Construction Standards-Metal and Flexible. Fabricate ducts larger than 72-inches in diameter with butt-welded longitudinal seams.
3. Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.
4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
5. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.

2.03 TYPE I, GREASE HOOD DUCTWORK

A. Materials:
1. Carbon Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets, commercial quality, with oiled, matte finish for exposed ducts.

B. Construction:
1. Weld or braze all joints, seams, and penetrations continuously and liquid tight on the external surface of the duct system.

2.04 TYPE II, VAPOR HOOD DUCTWORK

A. Materials:
1. Stainless Steel: Fabricated in accordance with ASTM A167 and A480.

B. Construction:
1. Weld or braze all joints, seams, and penetrations continuously and liquid tight on the external surface of the duct system.

2.05 LAUNDRY CLOTHES DRYER VENT

A. Aluminum sheet metal, minimum 24 gauge. Substantially airtight duct except for openings required for operation and maintenance. Duct to have smooth interior surface. Do not assemble with sheet metal screens or other devices that extend into the airstream.

2.06 INSULATED FLEXIBLE DUCT

A. Construction: Standard factory fabricated product. Inner wall: Impervious vinyl or chlorinated polyethylene, permanently bonded to a vinyl or zinc-coated spring steel helix.

B. Insulation: Fiberglass blanket insulation covered by an outer wall of vinyl or fiberglass-reinforced metalized vapor barrier.

C. Listing: UL 181 listed Class 1 flexible air duct material. Overall thermal transmission: No more than 0.25 BTU/in or hr/sq. degrees F at 75 degrees F differential, per ASTM C335.

D. Vapor transmission value no more than 0.10 perm, per ASTM E96

E. Pressure Rating: 4-inch wg positive pressure and 1-inch wg negative pressure.

F. Performance Air Friction Correction Factor: 1.3 maximum at 95 percent extension. Working air velocity: Minimum 2000 FPM.

G. Flame Spread Rating: No more than 25.

H. Smoke Development Rating: No more than 50 as tested per ASTM E84.

I. Insertion Loss: Minimum attenuation of 29 DB for 10-foot straight length at 8-inch diameter at 500 Hz.

2.07 DRAIN PANS

A. Primary Drain Pans: Stainless Steel, Fabricated in accordance with ASTM A167 and A480.

B. Secondary Drain Pans: Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M FS Type B, with G90/Z275 coating.

2.08 DUCTWORK JOINT SEALERS AND SEALANTS

A. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

B. Low Emitting Materials Requirement: Adhesives, sealants and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.

C. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.

D. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E 84.

E. Water Based Sealant for Brush-On Application: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts. Min. 69 percent solids, nonflammable. Durodyne Duroseal, Hardcast Versa-Grip 181, McGill United Duct Sealer.

F. Solvent Based Sealant for Brush-On Application: One-part, nonsag, solvent-release-curing, polymerized butyl sealant with a minimum of 75 percent solids, nonflammable. McGill Uni-Coat, Hardcast Sure-Grip, 404.

G. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.

H. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

I. Two-Part Tape and Adhesive System: Hardcast FTD 20/DT, McGill Air Seal Uni-Cast.

J. Silicon Sealant: Hardcast PT-302 or equal.

K. Polyurethane Sealant: General-purpose non-brittle sealant for gunned application. Vulkem 616 or equal.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. General: Use the following pressure class(es) in design of ductwork specified in this section unless otherwise noted on Drawings.

SYSTEM	PRESSURE IP (inches of water)	CLASS METRIC
Medium pressure supply (Fan to Terminal Unit (TU))	0.5-inch higher than air handlers discharge pressure (min. 4-inch pressure class).	996.4 PA
Low pressure supply (downstream of TU)	+ 1-inch	249 PA
Return main (>24-inch)	0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.	-498.2 PA
Return branch (<24-inch)	0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.	-249 PA
General exhaust	0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.	-498.2 PA
Kitchen grease exhaust	-6-inch	-1500 PA

B. Ductwork Installation:

1. General: Install entire duct system in accordance with drawings, Specifications, and latest issues of local Mechanical Code, NFPA 90A, and SMACNA Duct Construction Manual. At Contractor's option, rectangular ductwork may be resized to maintain an equivalent air

velocity and friction rate, while maintaining a maximum aspect ratio of 3. Remove markings and tagging from ductwork exterior surface in mechanical rooms and other locations where ductwork is exposed.

2. The duct layout shown on the Contract Drawings is diagrammatic in nature. Coordinate the ductwork routing and layout, and make alterations to the ductwork routing and layout to eliminate physical interferences. Where deviations in the ductwork routing as shown in the Contract Drawings are required, alterations may be made so as not to compromise the air flow, pressure drop, and sound characteristics of the duct fitting or duct run as shown on the Contract Drawings. In the event Architect determines that the installed ductwork is inconsistent with the above mentioned criteria, remove and replace at no additional cost to the Owner.
3. Install ducts with fewest possible joints.
4. Install fabricated fittings for changes in directions, size, shape, and for connections.
5. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12-inches, with a minimum of 3 screws in each coupling.
6. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
7. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
8. Install ducts with a clearance of 1-inch, plus allowance for insulation thickness. Allow for easy removal of ceiling tile.
9. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
10. Coordinate layout with suspended ceiling, air duct accessories, lighting layouts, and similar finish work.
11. Electrical and IT Equipment Spaces: route ducts to avoid passing through transformer vaults, electrical equipment spaces, IDF/MPOE rooms, and enclosures.
12. Boiler Rooms: Only route ducts serving these rooms through these rooms.
13. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2-inches.
14. Fire- and Smoke-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire, smoke or combination fire and smoke dampers as governed by Building Code and AHJ, including sleeves, and firestopping sealant.
15. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Reference SMACNA's Seismic Restraint Manual: Guidelines for Mechanical Systems, Mason Seismic Restraint and Support Systems.
16. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's Duct Cleanliness for New Construction Advanced Level.
17. Paint interiors of metal ducts, that do not have duct liner, for 24-inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible duct material.
18. Install ductwork in the location and manner shown and detailed. Review deviations required by job conditions with Architect prior to any fabrication. Provide fittings for construction per SMACNA.
19. Keep ducts out of weather prior to installation. Cover open ends of ducts after installed.

C. Flanged Take-Offs:
   1. Install at branch takeoffs to outlets using round or flex duct.
   2. Flanged take-offs secured with minimum 8-inch screw spacing (three screws minimum).
   3. Provide ductwork taps and branches off of main ducts at 45 degrees whether shown on Drawings or not (drawings are diagrammatic).

D. Cleaning:
   1. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.
   2. Grille and Exposed Duct Cleaning:
      a. After completion of ductwork installation, operate each fan system (excluding exhaust fans) for a minimum of 30 minutes prior to installation of ceiling grilles and diffusers. After grilles and diffusers are installed, clean out accumulation of particles from grilles and diffusers prior to acceptance.
      b. Clean exterior surface of ducts exposed to public view of chalk, pencil and pen marks, labels, sizing tags, dirt, dust, etc., so that upon completion of installation, ducts are left in clean and unblemished manufactured conditions.
      c. Exposed duct and grilles to remain free of dust entrained streaks due to leakage at joints and grille connections during warranty period. Clean leaks, seal and refinish to match existing if visible streaks develop.

3.02 DUCTWORK, JOINTS AND FITTINGS INSTALLATION

A. Duct Materials - Applied Locations:
   1. General: Use the following materials in design of ductwork specified in this Section unless otherwise noted on the Drawings.

Location or Application	Material
Supply, Return, Transfer, and Exhaust - Low Pressure (downstream of terminal units)	Single Wall, Galvanized Steel
Supply, Return, and Exhaust - Medium Pressure (upstream of terminal units)	Single Wall, Galvanized Steel

B. Ductwork Installation:
   1. Fabricate radius elbows with centerline radius not less than 1-1/2 duct diameters.
   2. Do not install duct size transition pitch angles which exceed 30 degrees for reductions in duct size in the direction of airflow, and 15 degrees for expansions in duct size in the direction of airflow.
   3. Install fixed turning vanes in square throat rectangular elbows and in tees.
   4. Fabricate duct turns with the inside (smallest) radius at least equal to the duct width (supply ducts) and 1.5 times radius (return and exhaust ducts). Where necessary, square elbows may be used, with maximum available inside radius and with fixed turning vanes. In healthcare settings such as hospitals and medical office buildings, square elbows and turning vanes allowed on supply ductwork only.

3.03 TYPE I, GREASE HOOD DUCTWORK INSTALLATION

A. Range Hood Exhaust Ducts, Special Installation Requirements (Type, 1 Grease Hood):
   1. Install ducts to allow for thermal expansion through 2000 degrees F temperature range.
   2. Install ducts without dips or traps that may collect residues unless traps have continuous to automatic residue removal.
   3. Install access openings at each change in direction and at intervals defined by NFPA 96; locate on sides of duct a minimum of 1-1/2-inches from bottom, and fit with grease-tight covers of same material as duct.
   4. Slope of Duct:
      a. 1-inch per foot.
         1) Toward hood.
         2) Toward approved grease reservoir.
      b. Exception: 1/4-inch per foot allowed.
         1) Length not to exceed 75-feet.
         2) Approved fire extinguishing system in duct.
   5. Duct Enclosure:

a. With enclosure access doors.
b. See Architectural drawings.
c. Where duct enclosures are not shown, install duct wrap as approved by AHJ, see insulation specification in Division 23, HVAC.

6. Cleanout Doors:
   a. Horizontal ducts:
      1) Maximum 20-feet on center.
      2) At grease reservoirs.
      3) At changes in direction.
      4) At fire protection devices.
      5) Bottom edge not less than 2-inches above bottom of duct.
   b. Vertical ducts: At base.
   c. Size:
      1) Maximum 24-inches by 24-inches.
      2) Minimum 24-inches one side, other side 2-inches less than duct height.
   d. Coordinate location with duct enclosure access doors.
   e. Where grease exhaust fire wrap is utilized, provide access doors per manufacturers recommendation and installation requirements.
7. Do not penetrate fire-rated assemblies except as permitted by applicable building codes.

3.04 TYPE II, VAPOR HOOD DUCTWORK INSTALLATION

A. Dishwasher Hood Exhaust (Type II, Vapor Hood):
   1. Slope duct 1-inch per foot down toward dishwasher.
   2. If above slope is impossible, slope 1/4-inch per foot down in direction of air flow to low-point drain.
   3. Do not cross break bottom panels of duct.

3.05 LAUNDRY CLOTHES DRYER VENT

A. Install vent in accordance with manufacturer's instructions and recommendations.

3.06 INSULATED FLEXIBLE DUCT INSTALLATION

A. Install flexible duct with bend radius equal to 1.5 times the diameter. Minimum length 2-feet. Maximum length 5-feet, unless noted otherwise.
   1. Provide round neck grilles/diffusers or square-to-round transitions. Flex duct connections directly to square neck not allowed.
   2. Flex duct allowed in concealed spaces above lay-in ceilings only.

3.07 DRAIN PANS INSTALLATION

A. Install where shown on Drawings. Drain provided by Division 22, Plumbing. Provide drain (sized per code) connection from each drain pan and pipe to nearest floor drain through trap and 10-inch air gap. Drain pans over 6-feet in length require drain connections from both ends. Pitch drain pans in direction of air flow and to drain. Support secondary drain pan independently from equipment.

3.08 DUCTWORK JOINT SEALERS AND SEALANTS INSTALLATION

A. Joints and Seam Joint Sealing:
   1. Seal duct seams and joints according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible for duct pressure class indicated.
   2. For pressure classes lower than 2-inch wg (500 Pa), seal transverse joints.
   3. Seal ducts before external insulation is applied.
   4. Fasteners such as sheet-metal screws, machine screws or rivets to be cadmium plated.
   5. Rectangular Ductwork: Where intermediate joint reinforcement is required for duct of negative pressure class, pre-drill stiffening flange and provide fastener maximum 8-inches on center. Where retaining flanges are welded to duct wall, paint welds with zinc coating.
   6. Single Wall Round Ductwork: Joint to incorporate beaded slip collar with minimum #8 sheet metal screws 8-inches on center. Seal ductwork as specified in this Section.

7. Seal joints and seams. Apply sealant to make end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
8. Double Wall Round Ductwork: Joint to incorporate beaded slip collar or flanged connection, with minimum #8 sheet metal screws 8-inches on center. Seal ductwork as specified in this Section.
9. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
10. Provide openings in ductwork where required to accommodate thermometers and control devices. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
11. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities as well as Code required clearances.

END OF SECTION

SECTION 23 3300
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Sheet Metal Materials
   2. Backdraft Dampers
   3. Dampers
   4. Concealed Damper Hardware
   5. Access Doors
   6. Duct Test Holes
   7. Control Dampers
   8. Turning Vanes
   9. Flexible Connectors

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Manufacturer's catalog data and fabrication/installation drawings for each factory fabricated duct accessory. Include leakage, pressure drop and maximum back pressure data.
   2. Shop Drawings: Indicate air duct accessories.
   3. Manufacturer's installation instructions: Provide instructions for each factory fabricated duct accessory.
   4. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      a. See Division 01, General Requirements, Product Requirements for additional provisions.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this Section, with minimum five years of documented experience.
   2. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
   3. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
   4. AMCA 511 - Certified Ratings Program for Air Control Devices.
   5. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
   6. NFPA 101 - Life Safety Code.
   7. UL 555 - Standard for Safety; Fire Dampers.
   8. UL 555S - Standard for Safety; Leakage Rated Dampers for Use in Smoke Control Systems.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Sheet Metal Materials:
   1. Not applicable.

B. Backdraft Dampers:
   1. Air Balance
   2. Cesco
   3. Greenheck
   4. Nailor
   5. Ruskin
   6. Or approved equivalent.

C. Dampers:
   1. Air Balance
   2. Cesco
   3. Greenheck
   4. Nailor
   5. Ruskin
   6. Or approved equivalent.

D. Concealed Damper Hardware, Cable System:
   1. Young Regulator Company
   2. Or approved equivalent.

E. Access Doors:
   1. Ductmate
   2. Cesco
   3. Ruskin
   4. Nailor
   5. Outdoor Installation: Karp MX insulated exterior access door.
   6. Or approved equivalent.

F. Duct Test Holes:
   1. Ventlok
   2. Or approved equivalent.

G. Control Dampers:
   1. Ruskin
   2. Greenheck
   3. CESCO
   4. Air Balance
   5. Nailor
   6. Or approved equivalent.

H. Duct Silencers:
   1. Industrial Noise Control
   2. Ruskin Co.
   3. Vibro-Acoustics
   4. Or approved equivalent.

I. Turning Vanes:
   1. Aerodyne
   2. Ductmate Industries
   3. Duro Dyne Corp

4. Metalaire Inc.
5. Ward Industries
6. Or approved equivalent.

J. Flexible Connectors:
1. Duro Dyne Corp.
2. Ventfabrics Inc.
3. Ward Industries
4. Or approved equivalent.

2.02 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M. Galvanizing: 1-1/4 ounces per square foot total both sides; ducts to have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for stainless-steel ducts.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36-inches or less; 3/8-inch minimum diameter for lengths longer than 36-inches.

2.03 BACKDRAFT DAMPERS

A. Basis-of-Design: Ruskin CB D6.

B. Description: Multiple-blade gravity balanced with center pivoted blades with sealed edges, assembled in rattle free manner with 90-degree stop, adjustment device to permit setting for varying differential static pressure.

C. Frame: 0.125-inch thick 6063-T5 extruded aluminum channel with galvanized steel braces at mitered corners. Provide mounting flange.

D. Blades: Single piece, overlap frame, parallel action, horizontal orientation, minimum 0.07-inch 6063-T5 extruded aluminum material, maximum 6-inch width.

E. Bearings: Corrosion-resistant synthetic, formed as single piece with axles.

F. Blade Seals: Extruded vinyl, mechanically attached to blade edge.

G. Blade Axles: Corrosion-resistant, synthetic formed as single piece with bearings, locked to blade.

H. Tie Bars and Brackets: Galvanized steel.

I. Return Spring: Adjustable tension.

J. Damper Capacity:
1. Closed Position: Maximum back pressure of 16-inches water gauge.
2. Open Position: Maximum air velocity of 2,500-feet per minute.

K. Counterbalances: Adjustable zinc plated steel weights mechanically attached to blade. Must be capable of operating over wide range of pressures.

L. Finish: Mill aluminum.

M. Temperature Rating: -40 degrees F to 200 degrees F.

N. Operation of Blade:
1. Start to Open: 0.01-inch wg
2. Fully Open: 0.05-inch.

O. Pressure Drop: Maximum 0.15-inch wg at 1,500-feet per minute through 24-inch by 24-inch damper.

P. Factory Sleeve: Minimum 20 gauge thickness, 12-inches in length.

Q. Screen: At outdoor intake or discharge. 1/4-inch aluminum.

2.04 DAMPERS

A. Basis-of-Design: Ruskin MD 35.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
   1. Pressure Classes of 3-Inch wg (750 Pa) or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Rectangular Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design with linkage concealed in frame and suitable for horizontal or vertical applications.
   1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum 16 gauge thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
      a. Roll-Formed Steel Blades: 16 gauge thick, galvanized sheet steel.
      b. Aluminum Frames: Hat-shaped, 10 gauge thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
      c. Roll-Formed Aluminum Blades: 10 gauge thick aluminum sheet.
      d. Extruded-Aluminum Blades: 16 gauge thick extruded aluminum.
      e. Blade Axles: Minimum 1/2-inch diameter, plated steel, hex shaped, mechanically attached to blade.
      f. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
      g. Tie Bars and Brackets: Galvanized steel.
      h. Mill galvanized.
      i. Capacity:
         1) Closed Position: Maximum pressure of 3-inches wg.
         2) Open Position: Maximum air velocity of 1,500-feet per minute across 24-inch by 24-inch damper.

D. Round Volume Dampers: Single-blade suitable for horizontal or vertical applications.
   1. Steel Frames: Galvanized, roll formed, minimum of 20 gauge thick with beads at each end.
   2. Blades: Minimum 20 gauge thick, galvanized sheet steel, round, single-piece.
   3. Aluminum Frames: Minimum 10 gauge thick aluminum sheet.
   4. Aluminum Blades: Minimum 10 gauge thick aluminum sheet.
   5. Extruded-Aluminum Blades: Minimum 16 gauge thick extruded aluminum.
   6. Blade Axles: Minimum 3/8-inch square, plated steel, mechanically attached to blade.
   7. Bearings: Molded synthetic sleeve, turning in hole in frame.
   8. Finish: Mill galvanized.
   9. Capacity:
      a. Closed Position: Maximum pressure of 3-inches wg
      b. Open Position: Maximum air velocity of 1,500-feet per minute.
   10. Leakage: Maximum 40 cfm at 1-inch wg for 20-inches diameter damper.
   11. Pressure Drop: Maximum 0.02-inch wg at 1,500-feet per minute through 20-inch diameter dampers.

E. Jackshaft: 1-inch diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
   2. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include 2-inch elevated platform for insulated duct mounting.

2.05 CONCEALED DAMPER HARDWARE

A. Concealed Damper Hardware: For dampers above non-removable ceilings (gyp, plaster, decorative, etc.) where access panels have not been shown on Architectural drawings or in locations where dampers are more than 2-feet above the ceiling, provide:
   1. Concealed Damper Regulator: Young Regulator Company Model 315 or approved equivalent.
   2. Cable System: Young Regulator Company or approved equivalent.
   3. Controller: Young Regulator Company 270-275 or approved equivalent.
   4. Control wrenches, wire stops, casing nuts, and stainless steel wire.
   5. Paint cover plate to match ceiling color or as directed by Architect.

2.06 ACCESS DOORS

A. Duct Pressure Class 2-inch WC and Greater: Sandwich-type design with threaded locking bolt assembly. Closed cell neoprene gasket permanently bonded to inside panel. Zinc-coated steel wing nuts or polypropylene molded knobs with threaded metal inserts - zinc coated bolts sealed to inner panel.

B. Duct Pressure Class 1-1/2-inch WC and Less: Galvanized steel assembly incorporating frame, door, hinges, and latch(es). Frame tabbed for attachment to duct panel. Double wall door panel with 1-inch insulation. Open cell neoprene gasket attached to frame. Cam latches for tight closure.

C. Plenum Doors: Extruded aluminum frames with extruded santoprene seals. Double-wall 20 gauge galvanized steel door panel with fiberglass insulation.

D. Size: Maximum size available to fit rectangular duct panel dimension or round duct diameter. Plenum doors minimum 2-feet wide by 4-feet high.

E. For outdoor installation, only provide waterproof access doors installed vertically.

2.07 DUCT TEST HOLES

A. Temporary Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.08 CONTROL DAMPERS

A. Basis-of-Design:
   1. Ruskin Model CD36, low leakage, for use in low pressure ductwork.
   2. Ruskin Model CDR25, low leakage, for use in low pressure round ductwork.
   3. Ruskin Model CDO25, low leakage, for use in low pressure oval ductwork.
   4. Ruskin Model CD60, ultra low leakage, for use in medium pressure ductwork.

B. Fabrication:
   1. Frame: 16 gauge roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gauge U-channel.
   2. Blades (Low Leakage Dampers):
      a. Style: Single skin with 3 longitudinal grooves.
      b. Action: Opposed blade for modulating applications, parallel blade for two position application.
      c. Orientation: Horizontal or vertical with thrust washers.
      d. Material: Minimum 16 gauge equivalent thickness, galvanized steel.
      e. Width: Nominal 6-inches.
   3. Blades (Ultra Low Leakage Dampers):
      a. Style: Airfoil-shaped, single-piece.
      b. Action: Opposed blade for modulating applications, parallel blade for two position applications.

c. Orientation: Horizontal or vertical with thrust washers.
d. Material: Minimum 14 gauge equivalent thickness, galvanized steel.
e. Width: Nominal 6-inches.

4. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
5. Seals:
   a. Blade: Inflatable PVC coated fiberglass material and galvanized steel. Mechanically attached to blade edge.
   b. Jamb: Flexible metal compression type.
6. Linkage: Concealed in frame.
7. Axles: Minimum 1/2-inch diameter plated steel, hex-shaped, mechanically attached to blade.
8. Mounting: Vertical or horizontal.
9. Finish: Mill galvanized for installation in galvanized sheet metal and Type 304 stainless steel for installation in stainless steel ductwork.

C. Performance Data (Low Leakage Dampers):
1. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
   a. Closed Position: Maximum pressure of 5-inches wg at a 12-inch blade length.
   b. Open Position: Maximum air velocity of 2,000-feet per minute.
2. Leakage: Maximum 3.7 cubic-feet per minute per square foot at 1-inch wg for sizes 36-inches wide and above.
3. Pressure Drop: Maximum 0.07-inch wg at 1,500-feet per minute across 24-inch by 24-inch damper.

D. Performance Data (Ultra Low Leakage Dampers):
1. Leakage: Damper to have a maximum leakage of 3 cfm per square foot at 1-inch wg and be AMCA licensed as Class 1A.
2. Differential Pressure:
   a. Damper to have a maximum differential pressure rating of 13-inch wg for a 12-inch blade.
3. Velocity: Damper to have a maximum velocity rating of 6,000-feet per minute.
4. Temperature: Damper rated for -72 degrees F to 275 degrees F.
5. Pressure Drop: Maximum 0.1-inch wg at 2,000-feet per minute across 24-inch by 24-inch damper.

E. Actuator: Provide actuator. See Specification Section 23 09 00, Instrumentation and Control for HVAC or 23 09 33, Electronic Control System for HVAC.

F. Factory flange frame

G. Factory Sleeve: Minimum 20 gauge thickness.

H. Duct Transition Connection: Per Drawings.

I. Factory Tests: Factory cycle damper assembly to assure proper operation.

2.09 DUCT SILENCERS

A. General Description: Factory-fabricated and -tested, round or rectangular silencers with performance characteristics and physical requirements as indicated.

B. Fire Performance: Adhesives, sealants, packing materials, and accessory materials to have fire ratings not exceeding 25 for flame-spread index and 50 for smoke-developed index when tested according to ASTM E 84.

C. Rectangular Units: Fabricate casings with a minimum of 0.034-inch-thick, solid galvanized sheet metal for outer casing and 0.022-inch thick, ASTM A 653/A 653M, G90 Z275, perforated galvanized sheet metal for inner casing. Provide stainless steel (type to match ductwork) solid liner for laboratory exhaust ductwork.

D. Round Units:
1. Outer Casings:

a. ASTM A 653/A 653M, G90 Z275, galvanized sheet steel.
b. Up to 24-inches in Diameter: 0.034-inch thick.
c. 26 through 40-inches in Diameter: 0.040-inch thick.
d. Casings fabricated of spiral lock-seam duct may be one size thinner than that indicated.

2. Interior Casing, Partitions, and Baffles:
a. ASTM A 653/A 653M, G90 Z275, galvanized sheet steel.
b. At least 0.034-inch thick and designed for minimum aerodynamic losses.

E. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffle sheet metal.

F. Fill Material: Moisture-proof nonfibrous material.
1. Erosion Barrier: Polymer bag enclosing fill and heat-sealed before assembly.

G. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.
1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
2. Lock form and seal or continuously weld joints.
3. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
4. Reinforcement: Cross or trapeze angles for rigid suspension.

H. Source Quality Control:
1. Acoustic Performance: Test according to ASTM E 477.
2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000-feet per minute face velocity.
3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.10 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners to automatically align vanes.

B. Manufactured Turning Vanes: For medium pressure ductwork, ductwork upstream of terminal units, and in ductwork with equal inlet width and height dimensions and outlet width and height dimension, provide double thickness airfoil turning vanes. Low pressure ductwork and ductwork downstream of terminal units use either single thickness or double thickness turning vanes. For mitered rectangular elbows with changes in size from inlet to outlet, only use single thickness turning vanes. Use 2-inch radius vanes spaced on centers of 1.5-inches for single thickness. Use 2-inch radius vanes spaced on centers of 2.125-inches for double thickness.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.11 FLEXIBLE CONNECTORS

A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

B. Metal-Edged Connectors: Factory fabricated with a fabric strip 4-inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Select metal compatible with ducts.

C. Indoor System, Flexible Connector Fabric (FC-1): Glass fabric double coated with neoprene.
1. Minimum Weight: 26 ounces per square yard.
2. Tensile Strength: 480 pounds of force per in the warp and 360 pounds of force per inch in the filling.
3. Service Temperature: -40 degrees F to 200 degrees F.

PART 3 - EXECUTION

3.01 DUCT ACCESSORIES GENERAL INSTALLATION

A. Inspect areas to receive air duct accessories. Notify Engineer of conditions that would adversely affect the installation of the dampers. Do not proceed until conditions are corrected.

B. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

C. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

D. Do not compress or stretch damper frames into duct or opening.

E. Handle dampers using sleeve or frame. Do not lift dampers using blades, actuators, or jack shafts.

F. Adjust duct accessories for proper settings.

3.02 SHEET METAL MATERIALS INSTALLATION

A. Install bracing for multiple Sections to support assembly weights and hold against system pressure. Install bracing as needed.

3.03 BACKDRAFT DAMPERS INSTALLATION

A. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated. Provide at outside air intakes where motorized dampers are not shown on drawings.

3.04 DAMPERS INSTALLATION

A. Where installing volume dampers in ducts with liner, avoid damage to and erosion of duct liner.

B. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts for air balancing. Install at a minimum of two duct widths from each branch takeoff. Provide balancing dampers for all air inlets and outlets.

C. Install dampers square and free from racking with blade running horizontally.

3.05 CONCEALED DAMPER HARDWARE INSTALLATION

A. Coordinate location in Reflected Ceiling Plan and color of concealed damper hardware with Architect prior to installation.

3.06 ACCESS DOORS INSTALLATION

A. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
   1. On both sides of duct coils.
   2. Downstream from volume dampers, turning vanes and equipment.
   3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
   4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot (15-m) spacing.
   5. Install the following sizes for duct-mounting, rectangular access doors:
      a. One-Hand or Inspection Access: 8-inches by 5-inches.
      b. Two-Hand Access: 12-inches by 6-inches.
      c. Head and Hand Access: 18-inches by 10-inches.
      d. Head and Shoulders Access: 21-inches by 14-inches.
      e. Body Access: 25-inches by 14-inches.
      f. Body Plus Ladder Access: 25-inches by 17-inches.
   6. Install the following sizes for duct-mounting, round access doors:
      a. One-Hand or Inspection Access: 8-inches in diameter.
      b. Two-Hand Access: 10-inches in diameter.
      c. Head and Hand Access: 12-inches in diameter.
      d. Head and Shoulders Access: 18-inches in diameter.

e. Body Access: 24-inches in diameter.

7. Label access doors.

3.07 DUCT TEST HOLES INSTALLATION

A. Provide test holes at fan inlets and outlets where indicated and where required for air testing and balancing.

3.08 CONTROL DAMPERS INSTALLATION

A. Handle dampers using sleeve or frame. Do not lift dampers using blades, actuators or jack shafts.

B. Install control dampers in accordance with manufacturer's written instructions.

3.09 TURNING VANES INSTALLATION

A. Vanes must be installed, eliminating every other vane is not allowed.

B. Single thickness vanes cannot be over 36-inches long without intermediate vane runner.

C. Install per SMACNA and fasten/support to prevent vibration, noise, and to maintain proper alignment at design velocity

3.10 FLEXIBLE CONNECTORS INSTALLATION

A. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators. Provide sheet metal weather cover over flexible connections located outdoors. Attach sheet metal to either equipment side or ductwork side, but not both.

B. Per NFPA, do not use flexible connectors on grease exhaust fans

C. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

D. Adjust the following types in the following locations:

1. FC-1: Indoors

END OF SECTION

SECTION 23 3400
HVAC FANS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Roof Exhaust Fans
   2. Cabinet Fans
   3. Ceiling Exhaust Fans
   4. In-Line Centrifugal Fans
   5. Dryer Vent Exhaust Fans

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material gauges and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Motors: Premium efficiency per Section 23 05 13, Common Motor Requirements for HVAC Equipment. Electrically Commutated Motors (ECM) where scheduled on Drawings.
   2. Sound power levels as scheduled on Drawings. If not scheduled, within 5 percent of Basis of Design at design flow.
   3. Project Altitude: Base air ratings on sea-level conditions for project sites below 2,000 feet in elevation. Base air ratings on actual site elevations for project sites above 2,000 feet in elevation.
   4. Operating Limits: Classify according to AMCA 99.
   5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   6. AMCA Compliance: Products are to comply with performance requirements and are to be licensed to use the AMCA-Certified Ratings Seal.
   7. NEMA Compliance: Motors and electrical accessories are to comply with NEMA standards.
   8. UL Standard: HVAC Fans are to comply with UL 705. Fans used in grease exhaust applications are to be UL 762 listed for grease exhaust.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.08 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Roof Exhaust Fans:
1. Greenheck
2. Cook
3. Carnes
4. PennBarry
5. Twin City
6. Or approved equivalent.

B. Cabinet Fans:
1. Cook
2. Greenheck
3. Carnes
4. PennBarry
5. Twin City
6. Or approved equivalent.

C. Ceiling Exhaust Fans:
1. Cook
2. Greenheck
3. Carnes
4. Broan
5. PennBarry
6. Twin City
7. Or approved equivalent.

D. In-Line Centrifugal Fans:
1. Greenheck
2. Cook
3. Carnes
4. PennBarry
5. Twin City
6. Or approved equivalent.

E. Dryer Vent Exhaust Fans:
1. Fantech Inc.
2. Tjernlund
3. Or approved equivalent.

2.02 ROOF EXHAUST FANS

A. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Wheel:
   1. Single width, single inlet, backward inclined/airfoil blades
   2. Aluminum hub and wheel with steel inlet bell.
   3. Statically and dynamically balanced with its own bearings.

C. Housing to match scheduled Basis of Design:
   1. One piece heavy gauge spun aluminum dome, hinged for service.
   2. Low silhouette type with arched heavy gauge galvanized hood
   3. Louvered type with heavy gauge extruded aluminum louvers
   4. Upblast discharge, heavy gauge spun aluminum, UL 762 for kitchen grease exhaust. Provide rain and snow drains.

D. Bearings and Drives:
   1. Bearings: Heavy duty pillow block type, self greasing ball bearings with ABMA 9 L-10 life at 100,000 hours.
   2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil.

E. Pulleys: Cast-iron, adjustable-pitch motor pulley.

F. Fan and motor isolated from exhaust airstream.

G. Curb: Prefabricated insulated roof curb, galvanized steel, mitered ad welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer, hinged with curb seal. Provide curb for flat, pitched or ridged roof as indicated.
   1. Kitchen grease exhaust meeting NFPA-96 requirements with vented slots. Greenheck VPFV or equal.

H. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors located indoors and TEFC for motors exposed to moisture.
   1. Inverter duty motor for use with variable frequency drive where indicated on Fan Schedule on Drawings.
   2. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.

I. Accessories:
   1. Inlet/Outlet Screens: Galvanized steel welded grid, removable.
   2. Backdraft Damper: Parallel blade heavy duty steel or aluminum, where scheduled, damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever. Motorized where indicated and gravity actuated with counterweight, where motorized is not indicated.
   3. AMCA 99 Type B spark proof construction where scheduled.
   4. Variable-Speed Controller: Where scheduled on Drawings, provide solid-state control to reduce speed from 100 percent to less than 50 percent.
   5. Disconnect Switch: Where not shown on Division 26, Electrical Drawings, provide nonfusible type, with thermal-overload protection mounted inside fan housing factory wired through an internal aluminum conduit.
   6. Vibration Isolation: Wheel and motor mounted on integral double deflection neoprene isolators.

2.03 CABINET FANS

A. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. Wheel:
   1. Double width, double inlet, forward curved blades.
   2. Spun inlet cones.

3. Statically and dynamically balanced within its own bearings.

C. Housing: Acoustically insulated steel casing, factory standard finish, bottom access, ducted inlet and outlet, backdraft damper.

D. Bearings and Drives
1. Bearings: Heavy duty pillow block type, self greasing ball bearings with ABMA 9 life at 50,000 hours.
2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil.
3. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves obtained with sheaves set at mid-position.

E. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

F. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors located indoors and TEFC for motors exposed to moisture.
1. Inverter duty motor for use with variable frequency drive where indicated on Fan Schedule on Drawings
2. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.

G. Accessories:
1. Discharge Dampers: Parallel blade heavy duty steel or aluminum, where scheduled damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever. Motorized where indicated and gravity actuated with counterweight, where motorized is not indicated.
2. AMCA 99 Type B spark proof construction where scheduled.
3. Variable Speed Controller: Where scheduled on Drawings, provide solid-state control to reduce speed from 100 percent to less than 50 percent.
4. Variable Speed Controller: Provide ECM motor.
5. Disconnect Switch: Where not shown on Division 26, Electrical Drawings, provide nonfusible type, with thermal-overload protection mounted inside fan housing factory wired through an internal aluminum conduit.

2.04 CEILING EXHAUST FANS

A. Description: Centrifugal fan, direct drive, cabinet and exhaust grille. AMCA rated. Sound level as scheduled. Fan shrouds, motor, and fan wheel are to be removable for service.

B. Wheel: Double width, double inlet, forward curved blades:

C. Housing: Acoustically insulated steel casing, factory standard finish, bottom access through grille, ducted outlet, egg crate inlet grille. Provide stainless steel grille where scheduled.

D. Drives: Direct drive.

E. Back draft damper.

F. Accessories:
1. Disconnect plug.

G. Motor: Integrally mounted with pre-lubricated sealed ball bearings.
1. Variable-Speed Controller: Where scheduled on Drawings, provide solid-state control to reduce speed from 100 percent to less than 50 percent.
2. Disconnect Switch: Where not shown on Division 26, Electrical Drawings, provide nonfusible type, with thermal-overload protection mounted inside fan housing factory wired through an internal aluminum conduit.
3. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
4. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
5. Motion Sensor: Motion detector with adjustable shutoff timer.
6. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.

H. Filter: Washable aluminum to fit between fan and grille.

I. Isolation: Rubber-in-shear vibration isolators.

2.05 IN-LINE CENTRIFUGAL FANS

A. Description: In-line, belt-driven, centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

B. Wheel: Cast aluminum backward inclined with inlet cone statically and dynamically balanced within its own bearings.

C. Housing:
   1. Heavy gauge steel flat roof cap, hooded wall cap, pitched roof cap, elbow discharge with grille, and louvered wall discharge housing, factory standard finish.
   2. Removable panels for access to all interior components.
   3. Horizontal or vertical configuration, as indicated.
   4. Inlet and discharge duct collars.
   5. 1-inch thick, 1.5 pounds per cubic foot density fiberglass liner.
   6. Aluminum straightening vanes.
   7. Support bracket adaptable to floor, sidewall, or ceiling mounting.

D. Bearings and Drives:
   1. Bearings: Heavy duty pillow block type, self greasing ball bearings with ABMA 9 life at 50,000 hours.
   2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil.
   3. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 5 hp and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 7.5 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor. Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
      a. Inverter duty motor for use iwth variable frequency drive where indicated on Fan Schedule on Drawings.
   4. Drive: Direct drive matched to fan loads with speed controller. Motor encased in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.
      a. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.

E. Accessories:
   1. Belt guard.
   2. Motor cover for outdoor applications.
   3. Inlet and outlet guard.
   4. AMCA 99 Type B spark proof construction where scheduled.
   5. Variable-Speed Controller: Where scheduled on Drawings, provide solid-state control to reduce speed from 100 percent to less than 50 percent.
   6. Discharge Dampers: Parallel blade heavy duty steel or aluminum, where scheduled, damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever. Motorized where indicated and gravity actuated with counterweight, where motorized is not indicated.

F. Inlet/Outlet Screens: Galvanized steel welded grid, removable.

G. Vibration Isolation: Wheel and motor mounted on integral double deflection neoprene isolators.

H. Vibration isolation as scheduled and specified. Reference Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment.
   1. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors located indoors and TEFC for motors exposed to moisture.

2.06 DRYER VENT EXHAUST FANS

A. Description: UL-Listed in-line dryer vent exhaust for suitable for high moisture, dust, and lint loadings. Suitable for temperatures up to 140 degrees F.

B. Housing constructed of UV resistant ABS-PC Blend thermoplastic.

C. Wheel: Backward curved impellers with venture inlet.

D. Accessories:
   1. Secondary lint trap installed upstream of fan. Fantech DBLT4 or approved equivalent.
   2. Automatic switch to turn on/off fan set at 0.05-inches WG. with delay-on-break timer to maintain fan operation for up to 10 minutes after dryer is off.
   3. Integral external electrical terminal box with class B wiring and terminal strip.
   4. Internally mounted capacitor.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Install in accordance with manufacturer's instructions.

B. Install power ventilators level and plumb.

C. Fans used for exhaust of kitchen grease hoods are to be UL 762 listed for grease exhaust. Provide fans with grease terminator. Pipe from grease terminator to Code approved location.

D. Fans used for exhaust of moist air are to be constructed of aluminum construction and be warranted for their application in moist conditions.

E. Fans used in welding, chemical, and/or fume exhaust applications are to be of spark-proof construction and are to be protected with coatings as required to protect parts in the air stream from the chemicals and materials the fan will be exposed to.

F. Install floor-mounting units on concrete bases.

G. Units using vibration isolation devices are scheduled on Drawings.

H. Support suspended units from structure threaded steel rods and vibration isolation device scheduled on Drawings.

I. In seismic zones, restrain support units.

J. Install units with clearances for service and maintenance.

K. Provide fixed sheaves required for final air balance.

L. Provide safety screen where inlet or outlet is exposed.

M. Pipe scroll drains to nearest floor drain.

N. Provide backdraft dampers on discharge of exhaust fans and as indicated on Drawings.

O. Duct installation and connection requirements are specified in other Division 23, HVAC Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors per Section 23 33 00, Air Duct Accessories.

P. Install ducts adjacent to power ventilators to allow service and maintenance.

Q. Ground equipment.

R. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

S. Equipment Startup Checks:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Verify lubrication from bearings and other moving parts.
6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
7. Disable automatic temperature-control operators.

T. Starting Procedures:
1. Energize motor and adjust fan to indicated rpm.
2. Measure and record voltage and amperage.

U. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

V. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

W. Shut unit down and reconnect automatic temperature-control operators.

X. Replace fan and motor pulleys as required to achieve design airflow.

Y. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

Z. Adjust damper linkages for proper damper operation.

AA. Adjust belt tension.

AB. Lubricate bearings.

AC. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

AD. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

AE. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC fans. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

3.02 ROOF EXHAUST FANS

A. Secure roof exhaust fans to roof curbs with cadmium-plated hardware.

B. See 3.1, General Installation Requirements above.

3.03 CABINET FANS

A. See 3.1, General Installation Requirements above.

3.04 CEILING EXHAUST FANS

A. Ceiling Exhaust Fans: Suspend units from structure; use steel wire or metal straps.

B. See 3.1, General Installation Requirements above.

3.05 IN-LINE CENTRIFUGAL FANS

A. See 3.1, General Installation Requirements above.

3.06 DRYER VENT EXHAUST FANS

A. See 3.1, General Installation Requirements above.

END OF SECTION

SECTION 23 3600
AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Single Duct Variable Volume and Constant Volume Units

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Titus

B. Price

C. Krueger

D. Trane

E. Nailor

F. Or approved equivalent.

2.02 SINGLE DUCT VARIABLE VOLUME AND CONSTANT VOLUME UNITS

A. Casings: Minimum 22 gauge galvanized steel.

B. 1/2-inch dual density insulation which complies with UL 181 and NFPA 90A. Exposed insulation edges to be coated with NFPA 90A approved sealant to prevent entrainment of fibers in the airstream.

C. Casing Leakage: Maximum casing leakage not to exceed 10 cfm at 1-inch static pressure for inlet size larger than 12-inches and not to exceed 7 cfm at 1-inch static pressure for inlet size 12-inches and smaller.
   1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
   2. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 7 cfm maximum at inlet static pressure. Shaft to be clearly marked on the end to indicate damper position. Stickers or other removable markings are not acceptable. Damper to incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close off leakage to the maximum values shown in the damper leakage table.
   3. Flow Sensor: Integral averaging type flow sensor utilizing multiple sensing points with unit mounted calibration chart.

D. DDC Controls: Damper operator, sensor, and other devices compatible with temperature controls specified in 23 09 00, Instrumentation and Control Performance Specifications.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals and duct connection to air terminals are leak tight. Repair or replace air terminals and duct connections as required to eliminate leaks and retest to demonstrate compliance.

B. Verify that installation of each air terminal is according to the Contract Documents.

C. Check that inlet duct connections are as recommended by air terminal manufacturer to achieve proper performance.

D. Check that controls and control enclosure are accessible.

E. Verify that control connections are complete.

F. Check that nameplate and identification tag are visible.

G. Verify that controls respond to inputs as specified.

3.02 SINGLE DUCT VARIABLE VOLUME UNITS

A. Install in accordance with manufacturer's instructions. Install level and plumb.

B. Support units individually from structure. Do not support from adjacent ductwork.

C. Provide minimum five duct diameters minimum straight duct run upstream of terminal unit.

D. Minimum of 3-feet straight duct downstream of terminal unit prior to first outlet or first branch duct.

E. Branch inlet duct size to match unit inlet connection. For branch inlet ducts over 15-feet long, increase branch duct size one size and provide transition immediately upstream of minimum straight duct run.

F. Connect to ductwork in accordance with Section 23 31 00, HVAC Ducts and Casings.

G. Install heating coils in accordance with Section 23 82 16, Air Coils.

H. Verify that electric power is available and of the correct characteristics.

I. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to scheduled minimum percent full flow.

END OF SECTION

SECTION 23 3700
AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Grilles, Registers, Diffusers
   2. Louvers
   3. Gravity Intake and Relief Penthouses
   4. Roof Hoods

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
   2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
   3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size and accessories furnished.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Air Distribution Diffuser, Register, and Grille Schedule lists Basis of Design, with any specialty accessories, construction, finish or other criteria noted on schedule. Submitted air distribution must match criteria of Basis of Design:
      a. Construction materials and appearance.
      b. Frame/installation method.
      c. Isothermal throw plus or minus 5 percent at design flows shown on drawings.
      d. Noise Criteria: NC value plus or minus 1 at design flows shown on drawings.
      e. Accessories: Equal to Basis of Design.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23, HVAC sections, where more than a single type is specified for the application, provide single selection for each product category.

B. Grilles, Registers, Diffusers:
   1. Anemostat
   2. Carnes
   3. Environmental Air Products

4. Kruger
5. Metalaire
6. Nailor
7. Price Co.
8. Shoemaker
9. Titus
10. Tuttle & Bailey
11. Seiho
12. Or approved equivalent.

C. Louvers:
1. Ruskin Manufacturing
2. Pottorff
3. Carnes
4. Cesco
5. Greenheck
6. Or approved equivalent.

D. Gravity Intake and Relief Penthouses:
1. Acme
2. Carnes
3. Greenheck
4. JencoFan
5. ILG
6. Cook
7. Penn
8. Or approved equivalent.

E. Roof Hoods:
1. Greenheck
2. Cook
3. Or approved equivalent.

2.02 GRILLES, REGISTERS, DIFFUSERS

A. Diffuser, Register and Grille Schedule lists Basis of Design, with specialty accessories, construction, finish or other criteria noted on schedule. Submitted air distribution must match criteria of Basis of Design, including accessories and finish:
1. Matching construction materials and appearance. Equal installation method/frame.
2. Pressure drop equal to or less than Basis of Design at CFM on Drawings.
3. Throw: Isothermal jet throw plus or minus 5 percent of Basis of Design at CFM listed on Drawings.
4. Noise Criteria: Plus or minus 1 NC of Basis of Design at CFM listed on Drawings. If Basis of Design NC is below registered level, submitted must match. NC rating with 10 dB room factor or less.

B. Provide 1-, 2-, 3-, or 4-way deflection as indicated on Drawings.

C. Register Dampers: Dampers utilized with grilles. Opposed blade dampers utilizing a side operated worm drive which provides external duct operation. Slot the end of the shaft to receive a screwdriver. Factory assembled side operator. Construct of the same material as the grille. Manufacturer same as grilles/diffuser.

D. Coordinate mounting frames with ceiling construction type. Verify per reflected ceiling plans.

2.03 LOUVERS

A. General: Frame and sill styles compatible with adjacent substrate, specifically manufactured to fit into construction openings with accurate fit and adequate support for weatherproof installation. Reference Drawings and Specifications for types of substrate which will contain each type of louver. Construct of aluminum extrusions, ASTM B221, Alloy 6063-T5. Weld units

or use stainless steel fasteners. On inside face of exterior louvers, provide anodized aluminum wire bird screen mounted in removable extruded aluminum frames. AMCA licensed performance ratings.

B. Blades set 3 to 5-inches on center, 37.5 degree angle with rain hook on blade, minimum blade thickness 0.080-inch, drainable blade style. Minimum 57 percent free area for 48-by 48-inch unit. Maximum water penetration 0.01 ounce water psf free area at 1000 FPM. Maximum intake pressure drop of 0.10-inch wg at 750 FPM free velocity. Provide downspouts in jambs, designed to drain water from louver for minimum water cascade from blade to blade. Provide drain gutter in head frame and each blade.

C. Reference Drawings for free area required.

D. Provide access door in duct to clean birdscreen.

E. Finish: Factory Kynar 500 fluoropolymer spray finish color to be selected by Architect. Conform to AAMA 605.2. Apply coating following cleaning, and pretreatment. Dry louvers before final finish application. 1.2 mils total dry film thickness when baked at 450 degrees F for ten minutes.

2.04 GRAVITY INTAKE AND RELIEF PENTHOUSES

A. Stormproof, gravity type. Penthouse: Aluminum or fiberglass. Cover: Removable and lined with fiberglass insulation to prevent condensation. Provide aluminum bird screen, roof curb, and anti-condensation coating.

B. Finish: factory prime coat finish color to be selected.

2.05 ROOF HOODS

A. Unit Description: Hooded high-efficiency roof-mounted gravity ventilator.

B. Bolted and welded construction utilizing corrosion resistant fasteners. Construct hood of minimum 18 gauge aluminum, bolted to a minimum 8 gauge aluminum support structure. A radius throat must be provided for optimum performance. Provide lifting lugs to help prevent damage from improper lifting. Provide rain gutter to prevent rain infiltration. Continuously welded curb cap corners on base for maximum leak protection. Mount birdscreen constructed of 1/2-inch galvanized mesh in the hood. Unit to bear an engraved aluminum nameplate and shipped in ISTA Certified Transit Tested Packaging.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Install in accordance with manufacturer's instructions. Provide seismic supports, clips, and bracing per local code. Coordinate installation of framing. Provide complete coverage of rough openings by integral device flanges or auxiliary frames. Where above ceiling location is unconditioned space, caulk rough openings; repair and re-paint locations where dust entrainment streaks develop due to unsealed openings.

B. Damp locations, such as lockers, restrooms, showers, natatoriums, whirlpool/spas, to have aluminum construction even if scheduled otherwise; mounting hardware to be stainless steel.

C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

D. Adjust discharge direction and spread per Drawings. Adjust throws of air outlets to eliminate drafts and to distribute air during heating and cooling operation.

E. Exterior color of grilles per Architect. White finish if not otherwise scheduled or noted by Architect. Paint ductwork visible behind air outlets and inlets matte black.

F. Ceiling Membrane: Protect ceiling membrane per code. Fire caulk around openings. Provide listed radiation damper in rated roof/ceiling or floor/ceiling assemblies as required per code.

G. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

3.02 GRILLES, REGISTERS AND DIFFUSERS INSTALLATION

A. Coordinate with Architectural Reflected Ceiling Plan(s).

B. Install diffusers to ductwork with air tight connection. 18-inch straight duct Section or acoustic plenum at connection. Provide square to round adapters where required for connection to round ducts.

C. Provide integral balancing dampers for diffusers, and grilles and registers where duct manual balancing dampers are not shown or specified.

D. Linear Slot Diffusers:
   1. Coordinate connection plenum dimensions with linear slot final dimensions to conform with manufacturer's recommendations, or as indicated. Total and active lengths as noted on drawings. Blank off unused Sections. Coordinate frame type with Architect.
   2. Paint surfaces visible behind air outlets and inlets, including blank-off Sections, matte black unless otherwise called for on drawings.

3.03 LOUVER INSTALLATION

A. Install per manufacturer's recommendations.

3.04 GRAVITY INTAKE AND RELIEF PENTHOUSES INSTALLATION

A. Install per manufacturer's recommendations.

3.05 ROOF HOOD INSTALLATION

A. Install per manufacturer's recommendations.

END OF SECTION

SECTION 23 4000
HVAC AIR CLEANING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Disposable Panel Filters
   2. Medium Efficiency Pleated Filters
   3. Filter Gauges

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
   1. Division 01, General Requirements, Temporary Facilities and Controls: Filters for temporary heating and ventilating.
   2. Division 26, Electrical, Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. ARI 850 - Commercial and Industrial Air Filter Equipment; Air-Conditioning and Refrigeration Institute.
   2. ASHRAE Std 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
   3. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
   4. Standard 52.2 - Method of testing general ventilation air-cleaning devices for removal efficiency by particle size.
   5. UL 867 - Electrostatic Air Cleaners; Underwriters Laboratories Inc.
   6. UL 900 - Standard for Air Filter Units; Underwriters Laboratories Inc.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.
   2. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.
   3. Manufacturer's Installation Instructions: Indicate assembly and change-out procedures.
   4. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.
   5. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      a. See Division 01, General Requirements for additional provisions.
      b. Extra Filters: One set of each type and size.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 PERFORMANCE REQUIREMENTS

A. Conform to ARI 850, Standard for Performance Rating of Commercial and Industrial Air Filter Equipment, Section 7.4.
   1. Dust Spot Efficiency: Plus or minus 5 percent.

PART 2 - PRODUCTS

2.01 FILTER MANUFACTURERS

A. American Filtration Inc.

B. AAF International/American Air Filter

C. Camfil Farr Company

D. Eco-Air Products

E. Filtration Group

F. Flanders Corporation

G. Or approved equivalent.

2.02 DISPOSABLE PANEL FILTERS

A. Media: UL 900 Class 2, fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive.
   1. Nominal Size: 12 x 24-inches.
   2. Thickness: 1-inch.

B. Performance Rating:
   1. Face Velocity: 500 FPM.
   2. Face Velocity: 350 FPM (2.54 m/sec).
   3. Initial Resistance: 0.15-inch WG.
   4. Initial Resistance: 0.23-inch WG (37 Pa).
   5. Recommended Final Resistance: 0.50-inches WG.
   6. MERV Rating: 8.

C. Casing: Cardboard frame.

D. Holding Frames: 20 gauge minimum galvanized steel frame with expanded metal grid on outlet side and steel rod grid on inlet side, hinged with pull and retaining handles.

2.03 MEDIUM EFFICIENCY PLEATED FILTERS

A. Media: Blend of cotton and polyester fiber, pleated, support grid, enclosing frame, UL 900.
   1. Thickness 4-inch.

B. Performance Rating per ASHRAE Standard 52.2:
   1. MERV 13.
   2. Dust Spot Efficiency: 25 to 30 percent.
   3. Face Velocity: 500 FPM.
   4. Initial Resistance: 0.30-inch WG.
   5. Recommended Final Resistance: 0.90-inches WG.

C. Frame: Provide galvanized steel frame, including support hardware with air tight seal around frame, upstream servicing.

2.04 FILTER GAUGES

A. Manufacturers:
   1. Dwyer Instruments, Inc

2. H.O. Trerice Company
3. Weiss Instruments
4. _____

B. Direct Reading Dial: 3-1/2-inch diameter diaphragm actuated dial in metal case, vent valves, black figures on white background, front recalibration adjustment, range 0-0.5-inch WG, 2 percent of full scale accuracy.

C. Direct Reading Dial: 3-1/2-inch diameter diaphragm actuated dial in metal case, vent valves, black figures on white background, front recalibration adjustment, range 2.0-inch WG, 2 percent of full scale accuracy.

D. Inclined Manometer: One piece molded plastic with epoxy coated aluminum scale, inclined-vertical indicating tube and built-in spirit level, range 0-3-inch WG, 3 percent of full scale accuracy.

E. Accessories: Static pressure tips with integral compression fittings, 1/4-inch aluminum tubing, 2-way or 3-way vent valves.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install air cleaning devices in accordance with manufacturer's instructions.

B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Install filter gauge static pressure tips upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum, in accessible position. Adjust and level.

D. Operation During Construction: If air handlers are operated during construction, provide treated 2-inch media construction filter in front of prefilters and replace periodically to prevent dirt carryover. Install clean prefilters prior to air balancing.

E. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

F. Provide filter gauges on filter banks, installed with separate static pressure tips upstream and downstream of filters.

END OF SECTION

SECTION 23 5100
BREECHINGS, CHIMNEYS AND STACKS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Gas Fired Equipment Vents

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
   1. ASTM C 401 - Standard Classification of Alumina and Alumina-Silicate Castable Refractories, current edition.
   2. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; National Fire Protection Association, current edition.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
   2. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations.
   3. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.
   4. Submit venting system design and calculations.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 DEFINITIONS

A. Breeching: Vent Connector.

B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.

C. Smoke Pipe: Round, single wall vent connector.

D. Vent: That portion of venting system designed to convey flue gases directly outdoors from vent connector or from an appliance when vent connector is not used.

E. Vent Connector: That part of venting system that conducts flue gases from flue collar of an appliance to chimney or vent, and may include draft control device.

1.08 DESIGN REQUIREMENTS

A. Factory built vents and chimneys used for venting natural draft appliances comply with NFPA 211 and be UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. American Metal Products Group

B. Metal-Fab, Inc.

C. Selkirk Corporation

D. Metal Bestos, Inc.

E. Security Chimneys International

F. Or approved equivalent.

2.02 GAS FIRED EQUIPMENT VENTS

A. Positive Pressure Factory Built/85 Plus Percent Efficient Equipment:
   1. Double-walled insulated piping system. UL listed. Category II, III, and IV appliances. Construction to match manufacturer required flue rating. Inner wall minimum 0.035-inch-thick AL29-4C stainless steel. Outer wall minimum 0.025-inch-thick aluminized steel. Provide minimum 1-inch space between the inner and outer walls. List system by UL as 1400F Factory Built Chimneys with 2-inch clearance to combustibles for use with No. 2 fuel oil-fired equipment. Manufacturer system to join Sections, sealing gastight up to minimum 60-inch wg for temperatures up to 600F. Fittings, roof penetrations, thimbles supports, etc. of same manufacture and construction as straight Sections.

B. Positive Pressure ABS/PVC Vent
   1. Schedule 40, pressure-rated ABS or PVC pipe; must meet gas-fired equipment manufacturer requirements for installation (solid core or otherwise to meet temperature requirements).
   2. Combination vent/intake from manufacturer, roof/sidewall flashing.

C. Gravity Vent Systems:
   1. Type "B" factory fabricated, UL listed, doublewall flue, with aluminum inner wall, galvanized steel outer wall and 1/2-inch air space between unless noted otherwise. Provide twist-lock connectors, tall cone flashing, storm collar, and round birdproof/weatherproof top.
   2. Manufacturers: American Metal Products Group, Ecco, Industrial Chimney, Metalbestos, Simpson.

PART 3 - EXECUTION

3.01 BREECHING AND CHIMNEY INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 54.

C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.

D. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12-foot spacing, to adjacent structural surfaces, or at floor penetrations. Reference SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size.

E. Install concrete inserts for support of breechings, chimneys, and stacks in coordination with formwork.

F. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.

G. Coordinate installation of dampers, and induced draft fans.

H. Install vent dampers, locating close to draft hood collar, and secured to breeching.

I. Assemble and install stack Sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join Sections with acid-resistant joint cement. Connect base Section to foundation using anchor lugs.

J. Level and plumb chimney and stacks.

K. Clean breechings, chimneys, and stacks during installation, removing dust and debris.

L. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.

M. Provide minimum length of breeching to connect appliance to chimney.

3.02 GAS-FIRED EQUIPMENT VENTING INSTALLATION

A. General: Vent-type to match equipment manufacturer requirements: Category 1 or Category 4. Maintain clearances to combustible materials per code; double-wall, insulation, thimbles, etc. at reduced clearance locations as necessary. Vent termination clearances from buildings, building openings, ventilation intakes, etc. per code.

B. Atmospheric Gas-Fired Vents:
   1. Install venting in accordance with the manufacturer's recommendations and the requirements of the UL listing of the system.
   2. Extend venting to 4-feet minimum above the roof. Maintain clearances from other buildings, openings, intakes, etc. per code unless otherwise indicated. Provide guy wire supports for vents terminating 6-feet or higher above the roof.

C. Pressurized Gas-Fired Vents:
   1. Install venting in accordance with the manufacturer's recommendations and the requirements of the UL listing of the system. Concentric vent/intake systems to be installed per manufacturer's recommendations, minimum 12-inches above snow level.
   2. Maintain slope of vent per manufacturer's recommendations. Clearances to other buildings, openings, intakes, etc. per code unless otherwise indicated.
   3. ABS or PVC venting systems to be sized per manufacturer recommendations for minimum and maximum lengths. Total developed length must not exceed equipment listing; additional elbows may be required to meet minimum developed length.

END OF SECTION

SECTION 23 5200
HEATING BOILERS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Emergency Stop Pushbutton Switch
   2. Condensing Boilers

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
   1. Division 23, HVAC, Vibration and Seismic Controls for HVAC Equipment
   2. Division 23, HVAC, Hydronic Piping Specialties
   3. Division 23, HVAC, Steam and Condensate Piping and Pumps
   4. Division 23, HVAC, Breechings, Chimneys and Stacks
   5. Division 23, HVAC, Instrumentation and Control Performance Specifications
   6. Division 26, Electrical, Equipment Wiring

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product Data: Provide data indicating general assembly, components, controls, safety controls, flue venting system, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
   2. Shop Drawings: Indicate general assembly, components, controls, flue venting, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
   3. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
   4. Manufacturer's Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.
   5. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
   6. Provide documentation indicating compliance with local air quality management district.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this Section, with minimum three years of documented experience.
   2. Installer Qualifications: Company specializing in installing and servicing the products specified in this Section, with minimum 5 years of experience and approved by manufacturer.
   3. Air Quality: Provide documentation showing compliance with local Air Quality Management District.
   4. Equipment must meet local air quality management district requirements. Do not bid equipment that does not comply.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Emergency Stop Pushbutton Switch:
   1. Group Schneider/Square D Class 9001 SB5 Family
   2. Eaton
   3. Siemens
   4. General Electric
   5. Or approved equivalent.

B. Condensing Boilers:
   1. Lochinvar CREST
   2. Or approved equivalent.

2.02 EMERGENCY STOP PUSHBUTTON SWITCH

A. Provide 40mm diameter turn-reset red pushbutton operator with contact blocks to disconnect power to the boiler burner controls and gas service. Basis-of-Design: Square D Class 9001 Family XB5.

2.03 CONDENSING BOILERS

A. General: Packaged condensing hot water boiler, complete with boiler fittings, burner, UL/FM approved gas train suitable for natural gas, safety shut-off valve, gas differential regulator, air/fuel valve, gas pressure regulator, neutralization tank and boiler management system. Boiler constructed in accordance with Section IV of ASME Code for hot water heating boilers with a maximum working pressure of at least 100 PSI. CSA approved for direct vent boiler and compliance with ASME CSD-1 Code.

B. Performance: Boiler efficiency ratings independently tested in accordance with BTS-2000 Testing Standard for Efficiency of Commercial Space-Heating Boilers from the Hydronics Institute Division of AHRI (www.ahrinet.org), or ANSI Z21.13/CSA 4.9 Gas-Fired Low Pressure Steam and Hot Water Boilers. The certified thermal efficiency rating be at least 91 percent at test conditions. Unit must have increased efficiencies at reduced loading and entering water temperatures. Capacities as indicated on drawings.

C. Factory Test: Provide certified factory performance test and submit results.

D. Boiler Shell and Heat Exchanger: Stainless steel or cast iron and designed for full condensing. Boiler bear ASME stamp and be National-Board listed. Jacket insulation to be minimum of 2-inch thick fiberglass and encased in 18 gauge metal cabinet with prime and finish coat of paint. Boiler mounted on structural steel frame design and designed to local seismic zone requirements.

E. Condensate Neutralization System: Assembly complete with P-trap and sacrificial limestone chips.

F. Burner: All burner material exposed to the combustion zone to be of stainless steel construction. Variable speed forced draft blower connected to venturi tube modulates fuel and air mixture for minimum of 5:1 turndown and compensate for changes in barometric pressure, temperature and humidity. Provide burner complete with gas-electric ignition, fuel train, flame management panel and required valves. Burner to comply with SCAQMD Rule 1146.2 for low NOx equipment.

G. Boiler Trim: Safety valve ASME Section IV approved. Provide temperature and pressure gauge, low water cut-out, manual reset, operating controller, modulating controller and high limit temperature controller.

H. Gas Train: Factory package gas train to include manual shutoff valve, pressure regulating valve, dual safety gas valves, manual test valve, high-low pressure switches and manifold pressure gauge. Gas train meets FM insurance requirements, as well as UL and CSD-1 requirements. Gas pressure available at gas train is 2 PSI.

I. Minimum Water Temperature: 40 degrees F without any failure due to thermal shock or fireside condensation.

J. Boiler Controls: Panel mounted microprocessor based operating controls and safety devices for automatic operation. Controls to include operating controller with display board, control circuit transformer, fusing, electronic flame safeguard control, burner management system, operating status and fault indicators, air switch, relays, terminal strips and blower motor variable speed drive. Units prewired and include operating indicating light and alarm bell with silencer, single point electrical connection in NEMA 1 enclosure. Controller to include remote communications device for boiler management interface. Controller to be CSA listed. Controller to perform following functions:
   1. Electronic ignition
   2. Burner sequencing and flame supervision with safe start check, pre-purge, direct spark ignition and post purge. Flame rod or ultraviolet (UV) detector to prove combustion.
   3. Safety shutdown with display of error.
   4. Gas pressure supervision, air proving, high air pressure, high limit and frost protection.
   5. Display hot water supply temperature set point with ability to reset temperature based on signal from boiler management system.
   6. Over-temperature protection with manual reset in accordance with ASME and CSD-1.
   7. Electric low water cut-off with manual reset in accordance with ASME and CSD-1.

K. Provide boiler management system capable of interfacing with BAS via BACnet. Reference Section 23 09 00. Interface to share following information:
   1. Boiler status
   2. Firing rate for each boiler
   3. Boiler pump status
   4. Supply and return water temperatures
   5. Gas Burner: Forced draft for natural gas, adjustable combustion air supply, gas pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device and automatic 100 percent shut off. Burner includes drawer assembly with flame retention head and diffuser, blower and motor, orifices, gas train, main safety gas valve and low-high pressure gas switches.

L. Flue Venting: UL Listed stainless steel AL-29-4C positive pressure venting materials, as recommended by the boiler manufacturer. Sized and installed per manufacturer's installation in accordance with local mechanical code.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install boiler in accordance with manufacturer’s instructions.

B. Provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes, and fuel oil tanks. Pipe gas vents to atmosphere.

C. Boilers Installed in Battery: Do not install boilers closer than 48-inches from each other, except boilers that operate at up to 2,000,000 BTU/hr may be installed according to manufacturer's instructions.

D. Install boiler on concrete housekeeping base, sized minimum 4-inches larger than boiler base.

E. Provide piping connections and accessories as indicated. Reference Division 23, HVAC, Hydronic Specialties.

F. Pipe relief valves to nearest floor drains.

G. Pipe relief valves to outdoors.

H. Provide for connection to electrical service.

I. Provide all wiring between control panels and devices and unit.

J. Mount thermometer in boiler breeching within 12 inches of flue nozzle.

K. Pipe boiler drains to nearest floor drains.

L. Pipe condensate connections from boiler to neutralization system and from there to nearest floor drain.

3.02 SYSTEM START-UP

A. Provide the services of manufacturer's field representative for starting and testing unit.

B. After installation and pipe flushing, boil out boilers using chemical and procedure as recommended and supervised by boiler manufacturer.

C. Manufacturer shall provide report verifying that boilers have been inspected, cleaned and tested according to their recommendations.

3.03 CLOSEOUT ACTIVITIES

A. Train operating personnel in operation and maintenance of units.

B. Provide the services of manufacturer's field representative to conduct training.

3.04 BOILER SHUTDOWN

A. Remote switch: Install shutdown switch to disconnect power to the boiler burner controls and gas service in room. Install pushbutton under clear, impact-resistant flip lid. Provide red phenol label "Emergency Shutdown" locate label above pushbutton. Pushbutton to be mounted by latch side of each boiler/mechanical room door within interior of the room, unless otherwise directed by AHJ. Provide electrical wiring and raceway as necessary for installation. Provide additional relays and wiring to cut power to gas solenoid valves in the room not integral to boilers. Reference drawings for gas solenoid valve locations.

END OF SECTION

SECTION 23 6400
PACKAGED WATER CHILLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Air Cooled Water Chillers

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Chiller efficiency and capacity performance data to be certified per current version of AHRI Standard 550/590.
   2. Chiller acoustic sound performance data to be rated in accordance with current versio of AHRI STandard 370/575.
   3. Comply with Standards ANSI/ASHRAE 15 and ASME Section VIII.
   4. Electrical components except for motor to be listed and labeled by UL. Assemblies to be constructed in accordance with UL-465.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product Data: Provide rated capacities, weights, specialties and accessories refrigerant, electrical requirements and wiring diagrams.
   2. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, mounting and anchorage, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.
   3. Provide part load operating characteristics and application part load value calculation (NPLV) in accordance with AHRI Standard 550/590 Certified Reports for:
      a. EER Full Load and IPLV @ standard AHRI conditions.
      b. EER Full Load and NPLV @ design conditions.
      c. A-weighted sound level. Individual frequency range data to be db, not A-weighted. Note if data is sound pressure or sound power.
      d. Fluid pressure drops in feet head.
      e. Refrigerant type & volume in pounds per circuit.
      f. Fouling Factor (AHRI defaults unless noted otherwise)
      g. Elevation
      h. Percent & Type Glycol
   4. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Minimum 1 year parts, materials and labor and 5 year compressor parts-only warranty.

1.07 COORDINATION

A. Coordinate size and location of concrete bases including but not limited to sufficient base footprint to allow proper anchorage and anchor-bolt inserts.

B. Coordinate installation of roof curbs and penetrations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Air and Water Cooled Water Chillers:
   1. Trane
   2. Carrier
   3. Daikin Applied
   4. York
   5. Or approved equivalent.

2.02 AIR COOLED WATER CHILLER

A. Description:
   1. Factory assembled packaged air-cooled water chiller consisting of compressors, condensers, evaporator, lubrication system, refrigerant piping and specialties, wiring and operating and safety controls including motor starter and control center, contained on common frame. Unit fully charged with refrigerant at factory.
   2. Electrical components mounted in rain-tight enclosure.
   3. UL listed and labeled.
   4. Units to have Energy Efficiency Rating (EER)/Coefficient of Performance (COP) as indicated on drawings and not less than prescribed by ASHRAE Standard 90.1 or local energy codes. Performance certified per ARI 550-88 and based on 0.00010 fouling factors for evaporator.

B. Compressor: Direct drive, variable speed with factory installed variable speed controller, hermetic scroll compressors; positive displacement oil pump; suction and discharge service valve; internal muffler; crankcase heater; suction strainer; oil strainer; oil sight glass; and oil charging connection.

C. Motor: Continuous duty induction type, suction gas cooled and suitable for voltage fluctuation of plus or minus 10 percent of nameplate voltage. Provide solid-state thermal overload sensors in each motor winding and external overload protection on all three phases.

D. Evaporator: Shell and tube design with seamless copper tubes expanded into tube sheets and removable heads for mechanical tube cleaning. Units tested and stamped in accordance with ASME Code for Unfired Pressure Vessels for refrigerant side working pressure of 225 PSIG and waterside working pressure of 150 PSIG. Provide water manifold package for single supply and return water connections.

E. Evaporator: Plate-to-plate type heat exchanger consisting of parallel stainless steel plates brazed with copper braze material. Units tested and stamped in accordance with ASME Code for Unfired Pressure Vessels for refrigerant side working pressure of 225 PSIG and waterside working pressure of 150 PSIG. Provide water manifold package for single supply and return water connections and water strainer on supply with blow down valve.

F. Air-Cooled Condensers: Unit circuited to provide subcooling. Condensers constructed of 1/2-inch OD seamless copper tubes with mechanically bonded aluminum fins, leak tested at 150 PSIG, pressure tested at 450 PSIG.
   1. If subject to salt spray, provide complete coverage flexible epoxy or phenolic dip and back coating of condenser coils and fins, minimum 0.8 mils, rated for 5,000 salt spray test. Coating to include UV protection. Ensure bridging does not occur between fins. Maximum allowable degradation of heat transfer performance due to coatings is 1 percent.

G. Condenser Fans and Motors: Provide direct-drive, propeller type condenser fans, with steel wire safety guards and 3-phase, permanently lubricated and inherently protected Totally Enclosed Air-Over (TEAO) motors with corrosion resistant fan shaft.

H. Head Pressure Control: Provide head pressure control system by cycling fans based on combination of discharge pressure and ambient temperature to permit operation to 40 degrees F outdoor ambient temperature.

I. Head Pressure Control: Provide head pressure control system by varying speed of lead fan on each refrigeration circuit based to permit operation to 0 degrees F outdoor ambient temperature.

J. Refrigerant Circuit Accessories: Provide required refrigeration accessories including condenser liquid line valves, combination filter-dryers, solenoid liquid stop valves, liquid line sight glasses, expansion valves and isolation valves adequate to allow isolation and servicing of compressors, receivers, and evaporators.

K. Insulation: Factory insulate evaporator including heads and cold refrigerant piping, with 1-inch expanded polyvinyl chloride (K = 0.28) over evaporator to protect against freezing. Provide heat tape over evaporator to protect from freezing at ambient air temperatures to -20 degrees F.

L. Wiring: Field wiring to consist of single point electrical connection to chiller and 115V control interlock wiring to pumps and flow switches. Provide terminals.

M. Flow Switches: Provide flow switches in chilled water main for positive determination of water flow.

N. Control Panel: Unit equipped with control panel utilizing 120-volt, single phase power supply from transformer in starter and containing following microprocessor based accessories and features:
   1. Display of evaporator/condenser refrigerant pressures, oil pressure, return/leaving chilled water temperature, evaporator/condenser refrigerant temperatures, compressor discharge temperature, oil temperature, saturation temperature in evaporator and condenser, compressor run status (elapsed time meter).
   2. Provide programming of setpoints through keypad and include leaving chilled water temperature, percent current demand, and remote reset temperature range.
      a. Provide provisions for chilled water reset based on return-water temperature.
   3. Safety controls annunciated through alpha-numeric display and include high/low oil pressure, high/low refrigerant pressure, low chilled water temperature, starter faults, low flow through evaporator, high oil temperature, high compressor discharge temperature, high motor temperature high current.
   4. Battery back-up for control panel with circuit protection from high voltage and power surge conditions.
   5. Choice of control modes from hand/off/auto.
   6. Extra contact to annunciate machine failure to remote area and extra contact for safety shutdown from external source.
   7. Pilot relays to start chilled water pumps.
   8. Time limit control to limit starts to one in 30 minutes or as recommended by manufacturer.
   9. Communications to BAS to consist of BACnet, Lonmark, OPC or Modbus communications protocol. Coordinate with Division 23, HVAC, Instrumentation and Controls. Provide separate interface signal for BAS communications port to monitor and control following:
      a. Entering and leaving chilled water temperature
      b. Chilled water set point
      c. Current limit set point
      d. Runtime - Hours
      e. System Fault
      f. On/off Control Signal

O. Capacity Control: Electronic thermostat and controller to modulate capacity of machine to maintain constant (plus or minus 0.5 degree F) chilled water supply temperature. Chilled water temperature setpoint to be remotely adjustable from building control system. Coordinate requirements with Division 23, HVAC, Instrumentation and Controls. Machine modulates to within 20 percent capacity without using hot gas bypass per ARI 550 requirements.

P. Starter:
   1. Provide unit mounted starter cabinet with combination starter, and circuit breakers.
   2. Provide protection devices including 3 leg overload protection high temperature safety protection with indicating light and reset button, over and under voltage protection.
   3. Provide indicator lights on starter panel including control power on, chiller start, chiller run, overload current.

Q. Refrigerants: Chillers using HFC-134a or HFC-410A are acceptable. Chillers using other refrigerants are not acceptable unless prior approval received.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions. Maintain manufacturer's recommended clearances for service and maintenance.

B. Provide connection to electrical service.

C. Provide connection of electrical wiring between starter and chiller control panel, oil pump, and purge unit. Provide wiring between flow switches and control panel.

D. Install units on vibration isolation.

E. Provide seismic restraints in accordance with Division 23, HVAC Sections.

F. Provide evaporator connections to chilled water piping. Provide additional accessories as shown on details, schedule, and piping diagrams. (Additional requirements may be shown on Drawings).

G. Provide necessary auxiliary water piping for oil cooling units.

H. Provide condenser connections to condenser water piping. Provide additional accessories as shown on details, schedule, and piping diagrams.

I. Arrange piping for easy dismantling to permit tube cleaning and to permit for removal of chiller.

J. Provide piping from chiller rupture disc to outdoors. Size as recommended by manufacturer.

K. Install separate devises furnished by manufacturer.

3.02 STARTING EQUIPMENT AND SYSTEMS

A. Engage factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
   2. Verify that pumps are installed and functional.
   3. Verify that thermometers and gauges are installed.
   4. Operate water chiller for run-in period according to manufacturer's written instructions.
   5. Check bearing lubrication and oil levels.
   6. Verify that refrigerant pressure relief is vented outside.
   7. Verify proper motor rotation.
   8. Verify static deflection of vibration isolators, including deflection during water chiller and startup and shutdown.
   9. Verify and record performance of chilled- and condenser-water flow and low-temperature interlocks.
   10. Verify and record performance of water chiller protection devices.
   11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Prepare written startup report that records results of tests and inspections.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

F. Supply initial charge of refrigerant and oil.

G. Demonstrate system operation and verify specified performance.

END OF SECTION

SECTION 23 7500
SEMI-CUSTOM AIR HANDLING UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. General
   2. Cabinet, Casing and Frame
   3. Supply and Exhaust Fans
   4. Variable Air Volume Control
   5. Electrical
   6. Energy Recovery, Enthalpy Wheel
   7. Hydronic Coil Section
   8. Filters
   9. Outdoor/Return Air Section
   10. Controls

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. ARI 410 - Standard for Forced Circulation Air-Heating and Air-Cooling Coils.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Interior surfaces of units meet erosion and growth resistance requirements of ASHRAE 62.1, latest edition, as well as construction requirements for equipment.
   2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   3. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
   4. ARI Certification: Provide ARI certified and listed Units.
   5. Sound Power Level Ratings: Comply with ARI 270, "Sound Rating of Outdoor Unitary Equipment."
   6. Provide coils performing to ARI-410 Standards.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Belts: One Set for each belt-drive fan.
   2. Filters: One Set of filters for each unit.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. The following manufacturers will be considered provided they comply with Contract Documents.
   1. Daikin Applied
   2. Trane
   3. Energy Labs
   4. Governaire
   5. York/Johnson Controls
   6. Or approved equivalent.

2.02 GENERAL

A. Configuration: Fabricate as detailed on prints and drawings:
   1. Exhaust Fan/Economizer Section
   2. Filter Section
   3. Hydronic Coil Section
   4. Draw-through Supply Fan Section
   5. Energy Recovery Section (if equipped)

B. Provide complete unit ETL/MEA listed.

C. Provide units of a modular design with factory installed access Sections. Provide each unit factory split.

D. The unit to undergo a complete factory run test prior to shipment and factory test sheets to be available upon request. The factory test to include final balancing of the fan assemblies, and a unit control system operations checkout.

E. Units to have decals and tags to indicate caution areas and aid unit service. Provide unit nameplates fixed to the main control panel door. Provide electrical wiring diagrams attached to the control panels. Installation, operating and maintenance bulletins and start-up forms supplied with each unit.

F. Performance: Scheduled capacities and face areas are minimum accepted values. Scheduled amps and HP are maximum accepted values that allow scheduled capacity to be met.

2.03 CABINET, CASING AND FRAME

A. Standard double-wall construction for sidewall access doors and floor areas to be provided with 22 gauge solid galvanized steel inner liners to protect insulation during service and maintenance. Provide a minimum of 1-inch thick, 3/4-pound density Insulation, neoprene coated glass fiber. Design unit cabinet to operate at total static pressures up to 6.5-inches wg Insulation on ceiling and end panels secured with adhesive and mechanical fasteners.

B. Heavy gauge solid galvanized steel liners to be provided throughout, allowing no exposed insulation within the air stream. Cabinet insulation, except floor panels to be a nominal 2-inch thick, 1-1/2 pound density, R6.5, glass fiber.

C. Floor panels to include double wall construction and include a nominal 2-inch thick, 1-1/2 pound density, R6.5 glass fiber insulation.

D. Exterior surfaces constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat. Finished surface to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance. Service doors provided on both sides of each Section in order to provide user access to unit components. Service doors constructed of heavy gauge galvanized steel with a galvanized steel interior liner. Service doors mounted on multiple, stainless steel hinges and secured by a latch system that is operated by a single, flush mounted handle. The latch system to feature a staggered engagement. Removable panels, or doors secured by multiple, mechanical fasteners are not acceptable.

E. Provide unit base frame constructed of 13 gauge pre-painted galvanized steel. Provide lifting brackets on the unit base with lifting holes to accept cable or chain hooks.

2.04 SUPPLY AND EXHAUST FANS

A. Provide fan assemblies statically and dynamically balanced at the factory, including a final trim balance, prior to shipment. Provide fan assemblies to employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease lubricated ball bearings to be used. Provide bearings sized to provide an L-50 life at 200,000 hours. Entire fan assembly to be isolated from the fan bulkhead and mounted on spring isolators. Adjustable pitch V-belt drives with matching belts to be provided. V-belt drives to be selected at the manufacturer's standard service factor.

B. Provide heavy-duty fan motors, 1800 rpm open drip-proof (ODP) type with grease lubricated ball bearings. Motors to be premium efficiency. Provide motors mounted on an adjustable base that provides for proper alignment and belt tension adjustment.

C. Airfoil Fans:
   1. Provide double width supply fan, double inlet (DWDI) airfoil centrifugal fan. Provide fans mounted using shafts and hubs with mating keyways. Provide Class II type fans and fabricated from heavy-gauge aluminum. Fan blades to be continuously welded to the back plate and end rim.

D. Plug Fans:
   1. Description: Belt-driven or direct drive plug fans consisting of housing, wheel, fan shaft, bearings, motors, disconnect switch, drive assembly, mounting base, and accessories.
   2. Fan:
      a. Centrifugal plug fan, horizontal arrangement mounted on common welded steel base, non-overloading die-formed reinforced airfoil blades, fully welded to solid back plate and inlet shroud.
      b. Statically and dynamically balance wheel within its own bearings with maximum balance quality grade at bearings of G16 (0.20 in/sec peak velocity, filter-in as measured at fan RPM) for 5 hp and below and G6.3 (0.15 in/sec peak velocity, filter-in as measured at fan RPM) for 7.5 hp and above, per ANSI S2.19. AMCA 210 rated.
      c. Factory finish before assembly to manufacturer's standards. Prime coating on aluminum parts is not required.
   3. Bearings and Drives:
      a. Bearings: Spherical roller bearings, ABMA 9 L-10 life at 50,000 hours, factory lubricated with easy access grease fittings.
      b. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil and shaft guard.
      c. Bearing support bars to be structural channels of sufficient size and strength to ensure flat bearing mounting surface and proper structural support.
      d. Drive: Direct drive with motor shaft keyed and secured to fan housing.
   4. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors. Inverter duty motor for use with variable frequency drive where indicated on Fan Schedule Drawings.
   5. Vibration Isolation:
      a. 2-inch spring isolators for base, seismic snubber and thrust restraints.

E. Provide fan Sections with an expanded metal belt guard.

2.05 VARIABLE AIR VOLUME CONTROL

A. Provide electronic variable frequency drive for the supply and exhaust air fan where scheduled. Two independent drives, one per fan, to be provided. Each drive factory installed downstream of the filters in a manner that the drive(s) are directly cooled by the filtered, mixed air stream. Drives to meet UL Standard 95-5V and the variable frequency drive manufacturer to have specifically approved them for plenum duty application. Provide completed unit assembly listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly complete with a single handle latch mechanism. Mounting arrangements that expose drives to high temperature, unfiltered ambient air is not acceptable.

B. The unit manufacturer to install power and control wiring.

C. A manual bypass contactor arrangement to be provided. The bypass arrangement will allow fan operation at full design CFM, even if the drive has been removed for service.

D. Line reactors to be factory installed for each drive.

E. Provide supply air fan drive output controlled by the factory installed main unit control system and drive status and operating speed monitored and displayed at the main unit control panel.

F. The supply and return/exhaust fan drive outputs to be independently controlled in order to provide the control needed to maintain building pressure control. Supply and return/exhaust air fan drives that are slaved off of a common control output are not acceptable.

G. Factory run test drives prior to unit shipment.

H. See 23 0914, Variable Frequency Drives, for additional information.

2.06 ELECTRICAL

A. Unit wiring to comply with NEC requirements and with applicable UL standards. Electrical components to be UL recognized where applicable. Wiring and electrical components provided with unit to be number and color-coded and labeled according to the electrical diagram provided for easy identification. Provide unit with a factory wired weatherproof control panel. Unit to have a single point power terminal block for main power connection. Provide terminal board for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, high temperature sensor, and a 115-volt receptacle with a separate electrical connection to also be provided with unit. Provide each compressor and condenser fan motor furnished with contactors and inherent thermal overload protection. Supply and return fan motors to have contactors and external overload protection. Provide knockouts in the bottom of the main control panels for field wiring entrance. Protect 115-600 voltage wire from damage by raceways or conduit.

B. Factory installed and wired marine service light, with switch and receptacle, to be provided in the supply air and exhaust fan Section. The separate, main unit service receptacle electrical circuit to also power the light circuit.

C. Phase failure and under voltage protection on three-phase motors provided to prevent damage from single phasing, phase reversal, and low voltage conditions.

D. Provide ground fault protection to protect against arcing ground faults.

E. Provide the Following Accessories:
   1. Provide single non-fused disconnect switch for disconnecting electrical power at the unit. The second switch will service the condensing section. Provide disconnect switches mounted internally to the control panel and operated by an externally mounted handle. Externally mounted handle is designed to prohibit opening of the control panel door without the use of a service tool.

2.07 ENERGY RECOVERY, ENTHALPY WHEEL (HRV-1 ONLY)

A. Energy recovery to be an integral part of unit from the manufacturer.

B. No field assembly, ducting, or electrical wiring to be required with energy recovery.

C. Energy recovery to be provided through a total enthalpy wheel providing sensible and latent energy transfer.

D. Construction:
   1. Energy recovery wheel constructed of lightweight polymer substrate with permanently bonded silica gel dessicant.
   2. Individual pie-shaped wheel Sections removable from wheel cassette for maintenance.
   3. Wheel bearings selected to provide an L-10 life in excess of 400,000 hours.
   4. Rim to be continuous rolled stainless steel and the wheel connected to the shaft by means of taper locks.
   5. Energy wheel cassette to include seals, drive motor and drive belt.

E. Latent energy transferred entirely in the vapor phase.

F. Provide energy recovery cassette Underwriters Laboratories Recognized Component for electrical and fire safety.

G. The wheel drive motor to be an Underwriters Laboratory Recognized Component and mounted in the cassette frame and factory wired to main ventilator disconnect.

H. Thermal performance to be certified by the wheel manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and ARI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment.

I. Energy recovery wheel cassette to be accessible through a 2-inch thick, foam-injected, double-wall, hinged access door with quarter-turn latches.

2.08 HYDRONIC COIL SECTION

A. Two-pipe heating and cooling coil:
   1. Coil Section to be complete with factory piped cooling coil and sloped drain pan. Hinged access doors on both sides of the Section to provide access to the cooling coil and drain pan for inspection and cleaning.
   2. Submittals must demonstrate that scheduled unit leaving air temperature (LAT) is met, that fan and motor heat temperature rise (TR) have been considered, and scheduled entering air temperature (EAT) equals mixed air temperature (MAT)
   3. Draw-through cooling-Scheduled EAT equals cooling coil EAT and scheduled unit LAT equals cooling coil LAT plus TR.
   4. General: Extended surface type consisting of copper tubing mechanically expanded to bond with plate fins. Design for serpentine flow with one or more feeds from common supply and return headers. Arrange for counter flow operation.
   5. Factory Testing: Leak test coils under water at 300 PSIG minimum.
   6. Working Pressure: 50 percent greater than refrigerant suction pressure.
   7. Construction:
      a. Tubing: Seamless copper.
      b. Fins: Aluminum die formed plates. Continuous within the coil casing.
      c. Casing: 16 gauge galvanized steel.
      d. Headers: Seamless copper tube brazed to heat transfer tubes.
      e. Connections: Same end for supply and return unless noted otherwise. Provide refrigerant distributor with equal length feeds to each tube. Provide hot gas bypass connection at distributor where scheduled.
      f. Intermediate Supports: Provide for coils with finned length greater than 44-inches, with maximum spacing of 42-inches.

B. Provide stainless steel, positively sloped drain pan provided with the cooling coil. Drain pan to extend beyond the leaving side of the coil and underneath the cooling coil connections. Drain pan to have a minimum slope of 1/8-inch per foot to provide positive draining. Provide drain pan connected to a threaded drain connection extending through the unit base. Provide units with stacked cooling coils with a secondary drain pan piped to the primary drain pan.

2.09 FILTERS

A. Draw-through Filters:
   1. Provide unit with a draw-through filter Section. Supply filter Section complete with the filter rack as an integral part of the unit. Provide draw-through filter Section with panel or cartridge filters.
   2. Provide 2-inch thick pleated panel filters with efficiency/Merv rating scheduled. Provide filters frame mounted and to slide into galvanized steel racks contained within the unit. Install filters in an angular arrangement to maximize filter area and minimize filter face velocity. Provide filters accessible from both sides of the filter Section.
   3. Provide 12-inch deep with efficiency/Merv rating scheduled, UL Std. 900, Class 1, cartridge filters. Include 2” panel, with efficiency/Merv rating scheduled pre-filters. Provide cartridge filters consisting of filter media permanently attached to a metal frame and slide into a gasketed, extruded aluminum rack contained within the unit. Filter rack to have secondary

gasketed, hinged end panels to insure proper sealing. Provide filters accessible from both sides of the filter Section.

B. Final Filters Option:
   1. Provide Final Filters-Unit with a final filter Section downstream of the supply fan. Unit to have adequate length between the fan discharge and the final filters to allow for proper air distribution. Supply final filter Section complete with the filter rack as an integral part of the unit. Final filter Section to be provided with cartridge filters.
   2. Provide 12-inch deep with efficiency/Merv rating scheduled, UL Std. 900, Class 1, cartridge filters provided. For units with gas or electric heat, High Temperature cartridge filters rated for 500 degrees F to be used. Cartridge filters to consist of filter media permanently attached to a metal frame and slide into a gasketed, extruded aluminum rack contained within the unit. Filter rack to have secondary gasketed, hinged end panels to insure proper sealing. Provide filters accessible from both sides of the filter Section.

C. Provide filters with antimicrobial treatment.

2.10 OUTDOOR / RETURN AIR SECTION

A. Return Air Plenum:
   1. Provide unit with a return air plenum for handling 100 percent re-circulated air. 100 percent return air plenum to allow return air to enter from the bottom, side, or back of the unit as shown on drawings.

B. 0 percent - 100 percent Outdoor Air Economizer:
   1. Provide unit with an outdoor air economizer Section. The 0 to 100 percent outside air economizer Section to include outdoor, return, and exhaust air dampers. Outdoor air to enter from one side or both sides of the economizer Section through intake. The floor of the outdoor air intakes to provide for water drainage. The economizer Section to allow return air to enter from the bottom, side, or back of the unit as shown on drawings.
   2. Provide outside and return air dampers sized to handle 100 percent of the supply air volume. Provide dampers with opposed sets of parallel blades, arranged vertically to converge the return air and outdoor air streams in multiple, circular mixing patterns. Provide low leak dampers. Provide damper blades fully gasketed and side sealed. Damper leakage to be less than 0.2 percent at 1.5-inches static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Provide damper blades operated from multiple sets of linkages mounted on the leaving face of the dampers.
   3. Provide barometric exhaust damper to exhaust air out of the unit. An electric actuator to provide positive closure of the exhaust damper. Provide bird screen to prevent infiltration of rain and foreign materials. Provide exhaust damper blades lined with urethane gasketing on contact edges.
   4. Control of the dampers by a factory installed actuator. Damper actuator of the modulating, spring return type. If outdoor air is suitable for “free” cooling, the outdoor air dampers to modulate in response to the direct digital control system.

2.11 CONTROLS

A. Provide motor control relays and damper actuators wired to terminal strip in unit mounted control cabinet for low voltage field connections to third-party direct digital control system controller mounted in same controls cabinet.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Install in accordance with manufacturer's instructions.

B. Unit to be secured to structure per seismic installation details.

C. Inspection:
   1. Examine areas and conditions under which units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

D. Connections:

1. Piping installation requirements are specified in other Division 26, Electrical Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.
   a. Hydronic Piping: Comply with applicable requirements in Division 23, HVAC. Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.
3. Duct installation requirements are specified in other Division 23, HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
   a. Install ducts to unit with flexible duct connections.
4. Electrical System Connections: Comply with applicable requirements in Division 26, Electrical Sections for power wiring, switches, and motor controls.
5. Ground equipment according to Division 26, Electrical.
6. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Water Coil Installation:
   1. General:
      a. Comb damaged and bent fins.
      b. Install coils to drain in accordance with manufacturer's recommendations.
      c. Install filters upstream of supply and exhaust air handler coils prior to fan operation.

F. Field Quality Control:
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
   2. Perform the following field quality-control tests and inspections and prepare test reports:
      a. After installing rooftop air conditioners and after electrical circuitry has been energized, test units for compliance with requirements.
      b. Inspect for and remove shipping bolts, blocks, and tie-down straps.
      c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
      d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Remove malfunctioning units, replace with new units, and retest as specified above.

G. Startup Service:
   1. Engage a factory-authorized service representative to perform startup service.
   2. Protect or remove energy recovery devices prior to starting the units to insure damage does not occur to the devices or media. Replace at no cost to Owner if devices/media get damaged.
   3. Complete installation and startup checks according to manufacturer's written instructions and do the following:
      a. Inspect for visible damage to unit casing.
      b. Inspect internal insulation.
      c. Verify that labels are clearly visible.
      d. Verify that clearances have been provided for servicing.
      e. Verify that controls are connected and operable.
      f. Verify that filters are installed.
      g. Adjust vibration isolators.
      h. Lubricate bearings on fan.
      i. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
      j. Adjust fan belts to proper alignment and tension.
      k. Start unit according to manufacturer's written instructions.
         1) Start refrigeration system in summer only.

2) Complete startup sheets and attach copy with Contractor's startup report.

l. Inspect and record performance of interlocks and protective devices; verify sequences.

m. Operate unit for an initial period as recommended or required by manufacturer.

n. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.

o. After startup and performance testing, change filters, vacuum heat exchanger and coils, lubricate bearings and adjust belt tension

H. Adjusting:

1. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
2. Occupancy Adjustments: Within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

I. Demonstration:

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop air conditioners. Reference Division 01, General Requirements.

3.02 CABINET, CASING AND FRAME

A. See General Installation Requirements above.

B. Install in accordance with Construction Documents, manufacturers written requirements and instructions.

3.03 SUPPLY AND EXHAUST FANS

A. See General Installation Requirements above.

B. Install in accordance with Construction Documents, manufacturers written requirements and instructions.

3.04 VARIABLE AIR VOLUME CONTROL

A. See General Installation Requirements above.

B. Install in accordance with Construction Documents, manufacturers written requirements and instructions.

3.05 ELECTRICAL

A. See General Installation Requirements above.

B. Install in accordance with Construction Documents, manufacturers written requirements and instructions.

3.06 ENERGY RECOVERY, ENTHALPY WHEEL

A. See General Installation Requirements above.

B. Install in accordance with Construction Documents, manufacturers written requirements and instructions.

3.07 COIL SECTION

A. See General Installation Requirements above.

B. Install in accordance with Construction Documents, manufacturers written requirements and instructions.

3.08 FILTERS

A. See General Installation Requirements above.

B. Install in accordance with Construction Documents, manufacturers written requirements and instructions.

3.09 OUTDOOR/RETURN AIR SECTION

A. See General Installation Requirements above.

B. Install in accordance with Construction Documents, manufacturers written requirements and instructions.

3.10 CONTROLS

A. See General Installation Requirements above.

B. Install in accordance with Construction Documents, manufacturers written requirements and instructions.

END OF SECTION

SECTION 23 8126
SMALL SPLIT SYSTEM AND UNITARY HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included: Materials, installation and testing of:
   1. Ductless Split Systems - Cooling Only

1.02 RELATED SECTIONS

A. Contents of Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.

B. In addition, meet the following:
   1. ARI 210

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.

B. In addition, provide:
   1. Samples: Submit one sample of wall louver.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.

B. In addition, meet the following:
   1. Efficiency ratings, cooling/heating performance, fan performance, sound performance to meet or exceed Basis of Design as scheduled on Drawings.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.

B. In addition, provide:
   1. Refrigeration compressor(s): 5-year warranty.
   2. Furnace heat exchanger: 5-year warranty.

1.07 PACKAGED TERMINAL AIR CONDITIONER MOCK-UP

A. Install one unit that includes inside cabinet, wall sleeve, and wall louver.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Ductless Split Systems:
   1. Mitsubishi
   2. Sanyo
   3. Daikin Applied
   4. LG
   5. Carrier
   6. Friederich
   7. Or approved equivalent.

2.02 DUCTLESS SPLIT SYSTEMS - COOLING ONLY

A. Description: Self-contained, matched factory-engineered and assembled. Pre-wired indoor and outdoor units. UL/ETL listed.

B. Outdoor Unit:
   1. Self contained, consisting of cabinet, compressor system, condenser fan matched to indoor unit.
   2. Cabinet: Fabricated of galvanized steel, bonderized, and finished with powder coated baked enamel.
   3. Refrigerant System:
      a. HFC refrigerant or other refrigerant with zero ozone depletion potential (ODP)
      b. Compressor: To be inverter driven, hermetic rotary type.
   4. Air System:
      a. Fan: Propeller Type with one direct drive, inverter driven, variable speed motor.
      b. Motor: Premium efficiency with inherent protection, permanently lubricated bearings and variable speed drive compatible.
      c. Coil: Copper tubes and aluminum fins.
   5. Controls: Single source for both indoor and outdoor units, with low/high pressure switch.

C. Indoor Unit(s):
   1. Self contained wall mounted evaporator unit(s) matched to outdoor unit.
   2. Cabinet:
      a. Non-flammable, high impact polymer with a white finish.
      b. Power Source: To be a single point power connection or sub-fed from outdoor condensing unit.
   3. Refrigeration System: HFC refrigerant or other refrigerant with zero ozone depletion potential (ODP).
   4. Air System:
      a. Fan: An assembly with one or two inline fan(s) with a single direct drive motor.
      b. Filter: Polypropylene, furnished with the unit, removable and washable.
      c. Coil: Direct expansion type with copper tubes mechanically bonded into aluminum fins.
   5. Condensate Drain:
      a. Provide drain pan sloped to drain away from unit. Drain pan with a single drain connection.
      b. Condensate pump kit provided with unit.
      c. Secondary drain pan; Condensate overflow shut-off float switch and external alarm.
   6. Controls: Wired thermostat. Control to be integral with unit.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide vibration isolation: As scheduled.

B. Provide Seismic restraint.

C. Install with required clearances and access for maintenance.

D. Shut-off/hose kits for all hydronic connections.

E. Condensate piped to indirect waste connection; cleanouts at changes of direction; sized and sloped to drain per Code.

F. Furnace condensate drain per manufacturer's piping diagram.

G. Install factory furnished devices for field installation.

3.02 FIELD QUALITY CONTROL

A. Inspect for and remove shipping bolts, blocks and tie-down straps.

B. After energizing units: Test units for proper fan rotation. Test and adjust controls and internal safeties. Replace malfunctioning units and retest.

C. Thoroughly clean exposed portions of equipment. Install new filters prior to final test and balance and again prior to final acceptance.

END OF SECTION

SECTION 23 8200
TERMINAL HEAT TRANSFER EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Fan Coil Unit
   2. Electric Wall Heaters

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as outlined in Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. As specified in Articles below.

B. Or approved equivalent.

2.02 FAN COIL UNIT

A. Manufacturers:
   1. Trane
   2. Aaon
   3. Daikin Applied
   4. York/Johnson Controls
   5. Williams
   6. Environmental Technologies
   7. Temtrol
   8. Or approved equivalent.

B. Description: horizontal fan coil unit with cabinet, 2-pipe hydronic water coil, outdoor air damper, fan and motor assembly, filter and controls. UL listed and wired per NEC.

C. Cabinet: 18 gauge, welded and bolted construction, removable panels for access, ½-inch fiberglass interior insulation, condensate drain pan.

D. Coils: Seamless copper tubes with aluminum fins mechanically bonded to tubes, 250 PSI working pressure with manual air vent.

E. Fan and Motor: Forward curved centrifugal fan or fans, steel or aluminum construction, direct or belt drive, multi-speed permanent split capacitor motor with thermal overload protection, permanently lubricated bearings. ECM motor.

F. Filter: 1-inch, disposable panel filters.

G. Drain Pan: 18 gauge galvanized steel or 304 stainless steel, insulated with fire retardant closed cell foam, 7/8-inch OD male sweat fittings, overflow drain connection and pitched for positive drainage.

H. Secondary Drain Pan: 18 gauge galvanized steel with 7/8-inch OD male sweat fitting and pitched for proper drainage. Provide secondary drain pan below horizontal concealed fan coil units.

I. Configuration: As scheduled on drawings.

J. Electrical:
   1. Junction box: Pre-wire control components to junction box.
   2. Disconnect: Unit mounted disconnect switch on interior of unit.
   3. Fan Relay
   4. Single point power supply.

K. Control: Microprocessor based, integral fan speed switch sends signal to controller to operate fan on high/medium/low speed continuously. Adjustable temperature sensor signals controller to operate water valve and to maintain space temperature.

2.03 ELECTRIC WALL HEATERS

A. Manufacturers:
   1. Trane
   2. Markel
   3. Qmark
   4. Chromalox
   5. Or approved equivalent.

B. Description: Wall mounted forced air unit heater, including enclosure for recessed mounting, fan and motor, heating elements and wall box. UL listed and wired per NEC.

C. Cabinet: 20 gauge zinc coated steel, 16 gauge painted exterior grille

D. Fan and Motor: Propeller type fan, totally enclosed motor with permanently lubricated bearings and thermal overload protection, vandal proof.

E. Heating Element: Sealed tubular type with finned heating elements, manual reset thermal limit safety switch, fan purge limit to dissipate residual heat on heater shutdown.

F. Control: Built-in thermostat with accessible disconnect switch.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways. Check each piece of equipment for defects, verifying that items function properly and that adjustments have been made.

B. Fan Coils: Install per manufacturer's instructions. Provide shut-off valve, balance valve, drain valve, control valve, manual air vent.

C. Damaged Coils: Make every effort to prevent damage to both built-up coils and coils of packaged equipment. Comb damaged coil fins to be straight.

3.02 ELECTRIC HEAT INSTALLATION

A. Electric Wall Heaters:
   1. Install per manufacturer's instructions. Comply with NEC and UL listings.
   2. Install heaters in place with box trim flush with finished wall.
   3. Install thermostat as shown on drawings. Provide control wiring from thermostat to unit.

3.03 EXPANSION AND CONTRACTION

A. Provide for expansion of heating water lines with suitable anchors and swing joints or expansion bends made up with pipe fittings.

3.04 CLEANING

A. Prior to acceptance, thoroughly clean exposed portions of terminal heat transfer equipment, remove shipping labels and traces of foreign substance. Touch up scratched surfaces of radiant panels with factory matching paint.

END OF SECTION

SECTION 23 8216
AIR COILS

PART 1 - GENERAL

1.01 SUMMARY

A. Work included: Materials, installation and testing of:
   1. Water Coils

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. ARI 410 - Standard for Forced Circulation Air-Heating and Air-Cooling Coils.
   2. ASTM B117 - Standard Practice for Operating Salt Spray Apparatus.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements

B. In addition, provide:
   1. Product data for each coil including performance, dimensions, operating weights, pressure ratings.
   2. Computer selection sheet indicating performance including hot and cold side entering and leaving fluid/air conditions, flows, pressure drops, square feet of heating surface, fouling factor, and heat transfer surface dimensions and configuration.
   3. Refrigerant Coils: Provide capacity plot of suction pressure versus total load.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Coil capacity certified in accordance with ARI 410, latest edition.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Provide extended three year warranty for coils with corrosion protection coating.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Water Coils:
   1. Colmac
   2. Heatcraft
   3. USA Coil
   4. Or approved equivalent.

2.02 WATER COILS

A. General: Extended surface type consisting of copper tubing mechanically expanded to bond with plate fins. Design for serpentine flow with one or more feeds from common supply and return headers. Arrange for counter flow operation with supply connections at the bottom.

B. Performance: Provide capacity indicated at water flows no greater than scheduled.

C. Factory Testing: Leak test coils under water at 300 PSIG minimum.

D. Working Pressure: 150 PSIG.

E. Construction:
   1. Tubing: Seamless copper.
   2. Fins: aluminum die formed plates. Continuous within the coil casing.
   3. Casing: 16 gauge stainless steel.
   4. Headers: Seamless copper tube brazed to heat transfer tubes. Provide high point air vent fitting and low point drain fitting.
   5. Connections: Same end for supply and return unless noted otherwise.
   6. Intermediate Supports: Provide for coils with finned length greater than 44-inches, with maximum spacing of 42-inches.

F. Corrosion Protection: Baked on phenolic coating suitable for 3000 hours salt spray per ASTM-B117. Heresite P413.

PART 3 - EXECUTION

3.01 WATER COIL INSTALLATION

A. General:
   1. Comb damaged and bent fins.
   2. Install coils to drain in accordance with manufacturer's recommendations.
   3. Install filters upstream of supply and exhaust air handler coils prior to fan operation.
   4. Pipe drain connection to code approved location.
   5. For duct mounted coils, provide drain pan.

END OF SECTION

SECTION 26 0000
ELECTRICAL BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work included in 26 00 00, Electrical Basic Requirements applies to Division 26, Electrical work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of electrical systems for proposed project.

B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.

C. Definitions:
   1. Provide: To furnish and install, complete and ready for intended use.
   2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
   3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work furnished.
   4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent", substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
   5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.02 RELATED SECTIONS:

A. Contents of Section applies to Division 26, Electrical Contract Documents.

B. Related Work:
   1. Additional conditions apply to this Division including, but not limited to:
      a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. 01 33 00 Delegated Design Requirements: administrative and procedural requirements for Subcontractor Bidder-Engineered items.
      b. Drawings
      c. Addenda
      d. Owner/Architect Agreement
      e. Owner/Contractor Agreement
      f. Codes, Standards, Public Ordinances and Permits

1.03 REFERENCES AND STANDARDS

A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 26, Electrical Sections and those listed in this Section.

B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
   1. State of Oregon:
      a. OAR Oregon Administrative Rules
      b. OESC Oregon Electrical Specialty Code
      c. OFC Oregon Fire Code
      d. OMSC Oregon Mechanical Specialty Code
      e. OPSC Oregon Plumbing Specialty Code

f. OSSC Oregon Structural Specialty Code
g. OEESC Oregon Energy Efficiency Specialty Code
h. Oregon Elevator Specialty Code

C. General: Reference standards and guidelines include but are not limited to the latest adopted editions from:

1. ABA Architectural Barriers Act
2. ADA Americans with Disabilities Act
3. ANSI American National Standards Institute
4. APWA American Public Works Association
5. ASCE American Society of Civil Engineers
6. ASHRAE Guideline 0, the Commissioning Process
7. ASTM ASTM International
8. CFR Code of Federal Regulations
9. CSA CSA International
10. EEMAC Electrical Equipment Manufacturers Association of Canada
11. EPA Environmental Protection Agency
12. ETL Electrical Testing Laboratories
13. FCC Federal Communications Commission
14. FDA Food & Drug Administration
15. FM FM Global
16. IBC International Building Code
17. IEC International Electrotechnical Commission
18. IEEE Institute of Electrical and Electronics Engineers
19. IES Illuminating Engineering Society
20. ISO International Organization for Standardization
21. LEED Leadership in Energy and Environmental Design
22. MSS Manufacturers Standardization Society
23. NEC National Electric Code
24. NECA National Electrical Contractors Association
25. NEMA National Electrical Manufacturers Association
26. NETA National Electrical Testing Association
27. NFPA National Fire Protection Association
28. OSHA Occupational Safety and Health Administration
29. UBC Uniform Building Code
30. UL Underwriters Laboratories Inc.
31. USDA United States Department of Agriculture

D. See Division 26, Electrical individual Sections for additional references.

E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.

F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

1.04 SUBMITTALS

A. See Division 01, General Requirements for Submittal Procedures and Section 01 3300 Delegated Design Requirements, as well as individual Division 26, Electrical Sections.

B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.

C. In addition:

1. "No Exceptions Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. All transmissions/submissions to be submitted to Architect.
3. Product Data: Provide manufacturer's descriptive literature for products specified in Division 26, Electrical Sections.
4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the specifications and drawings.
    a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
    b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 26, Electrical specification Sections for specific items required in product data submittal outside of these requirements.
    c. See Division 26, Electrical individual Sections for additional submittal requirements outside of these requirements.
5. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of these additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
6. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Part 3 of this Section.
    a. Special Seismic Certification to be provided for the following equipment and components that are part of the designated seismic system pursuant to Section 13.2.2, ASCE/SEI (Structural Engineers Institute).
        1) Emergency and standby power systems equipment including generators, automatic paralleling switchgear, fuel tanks, and automatic transfer switches.
        2) Distribution panels including electrical panelboards, control panels, including fire alarm, and auxiliary or remote power supplies.
7. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 26, Electrical Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.
8. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
9. Substitutions and Variation from Basis of Design:
    a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable

manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.

b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

10. Shop Drawings: Provide coordinated shop drawings which include physical characteristics of all systems, device layout plans, and control wiring diagrams. Reference individual Division 26, Electrical specification Sections for additional requirements for shop drawings outside of these requirements.
    a. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
11. Samples: Provide samples when requested by individual Sections.
12. Resubmission Requirements:
    a. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
    b. Resubmit for review until review indicates no exceptions taken or "make corrections as noted".
13. Operation and Maintenance Manuals, Owners Instructions:
    a. Submit, at one time, electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
        1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
        2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment.
        3) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
        4) Include product certificates of warranties and guarantees.
        5) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.
        6) Include commissioning reports.
        7) Include copy of startup and test reports specific to each piece of equipment.
        8) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor

must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.

b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 26 00 00, Electrical Basic Requirements, Demonstration.

c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

14. Record Drawings:

a. Maintain at site at least one set of drawings for recording “As-constructed” conditions. Indicate on drawings changes to original documents by referencing revision document, and include buried elements, location of conduit, and location of concealed electrical items. Include items changed by field orders, supplemental instructions, and constructed conditions.

b. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.

c. At completion of project, input changes to original project on Revit Model and make one set of black-line drawings created from Revit Model in version/release equal to contract drawings. Submit Revit disk and drawings upon substantial completion.

d. See Division 26, Electrical individual Sections for additional items to include in record drawings.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements: Work and materials installed to conform with all local, State and Federal codes, and other applicable laws and regulations.

B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e. distribution equipment, duct banks, light fixtures, etc.) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.

C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.

D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.

E. UL and CSA Compliance: Provide products which are UL listed

1.06 WARRANTY

A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.07 COORDINATION DOCUMENTS

A. Prepare and submit coordinated layout drawings (composite drawings), prior to construction, to coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, plumbing, lights, cable tray and electrical services with architectural and structural requirements, and other trades (including plumbing, fire protection, electrical, ceiling suspension, and tile systems), and provide maintenance access

requirements. Coordinate with submitted architectural systems (i.e roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence. Unless otherwise required by Division 00, Procurement and Contracting Requirements or Division 01, General Requirements, Division 23, HVAC to combine information furnished by other trades into master coordination documents.

B. Prepare Drawings as follows:
   1. Drawings in Revit Model. Revit Model release equal to design documents. Drawings to be same sheet size and scale as Contract Drawings and indicate location, size and elevation above finished floor of equipment and distribution systems.
   2. Review and revise, as necessary, Section cuts in Contract Drawings after verification of field conditions.
   3. Incorporate Addenda items and change orders.
   4. Provide additional coordination as requested by other trades.

C. Advise Architect in event conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.

D. Verify in field exact size, location, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.

E. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide like items from one manufacturer.

2.02 MATERIALS

A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL approved or have adequate approval or be acceptable by state, county, and city authorities. Equipment/fixture supplier is responsible for obtaining State, County, and City acceptance on equipment/fixtures that are not UL approved or are not listed for installation.

B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.

C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

D. Hazardous Materials:
   1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
   2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
   3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.03 ACCESS PANELS

A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.

B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 26, Electrical Sections. In the absence of specific requirements, comply with the following:
   1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
      a. Ceiling access panels to be minimum of 24-inch by 24-inch.

b. Wall access panels to be minimum of 12-inch by 12-inch.
c. Provide screwdriver operated catch.
d. Manufacturers and Models:
    1) Drywall: Karp KDW.
    2) Plaster: Karp DSC-214PL.
    3) Masonry: Karp DSC-214M.
    4) 2 hour rated: Karp KPF-350FR.
    5) Manufacturers: Milcor, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.01 ACCESSIBILITY AND INSTALLATION

A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Install equipment requiring access (i.e., junction boxes, light fixtures, power supplies, motors, etc.) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in passageways, doorways, scuttles or crawlspaces which would impede or block the intended usage.

C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines.

D. Earthwork:
    1. Confirm Earthwork requirements in Contract Documents. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
        a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork Sections. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
        b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
        c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.

E. Firestopping:
    1. Confirm requirements in Division 07, Thermal and Moisture Protection. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
        a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

F. Plenums:
    1. In plenums, provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.

G. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

H. Provide miscellaneous supports/metals required for installation of equipment and conduit.

I. Utility Tunnels:

1. Contractor will coordinate with other trades for services installed within the utility tunnels. Service piping shall be installed such as to maintain a clear passage for a repairman to move and work inside the tunnels.
    a. A 24-inch cross-sectional area will be provided along all portions of the tunnel for service access. This area shall extend from the bottom to top of the tunnel.
    b. The floor shall be maintained clear from any pipe installations. Should piping be proposed for the service access area, it will be submitted as a shop drawing for review and acceptance prior to pipe installation.
    c. The utility tunnels will be left clean with no construction debris.

3.02 SEISMIC CONTROL

A. Confirm Seismic Control requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26 Electrical Sections.

B. Equipment Importance Factor: 1.0.

C. General:
1. Confirm Building Occupancy Category and Seismic Design Category with Structural Engineer.
2. Earthquake resistant designs for Electrical (Division 26, Electrical) equipment and distribution, i.e. power distribution equipment, generators, UPS, etc. to conform to regulations of jurisdiction having authority.
3. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
4. Provide stamped shop drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for conduit and equipment. Submit shop drawings along with equipment submittals.
5. Provide stamped shop drawings from licensed Structural Engineer of seismic flexible joints for conduit crossing building expansion or seismic joints. Submit shop drawings along with seismic bracing details. Coordinate exact design requirements with project Structural Engineer.

D. Equipment:
1. Provide means to prohibit excessive motion of electrical equipment during earthquake.

3.03 REVIEW AND OBSERVATION

A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
1. Underground conduit installation prior to backfilling.
2. Prior to covering walls.
3. Prior to ceiling cover/installation.
4. When main systems, or portions of, are being tested and ready for inspection by AHJ.

C. Final Punch:
1. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.04 CONTINUITY OF SERVICE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:

1. During remodeling or addition to existing structure, while existing structure is occupied, present services to remain intact until new construction, facilities or equipment is installed.
2. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new wiring, and wiring to point of connection.
3. Coordinate transfer time to new service with Owner. If required, perform transfer during off-peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
    a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
4. No interruption of services to any part of existing facilities will be permitted without express permission in each instance from Owner. Requests for outages must state specific dates, hours and maximum durations, with outages kept to these specific dates, hours and maximum durations. Obtain written permission from Owner for any interruption of power, lighting or signal circuits and systems.
    a. Organize work to minimize duration of power interruption.
    b. Coordinate utility service outages with utility company.

3.05 CUTTING AND PATCHING

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:
    1. Proposed floor cutting/core drilling/sleeve locations to be approved by project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
    2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
    3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
    4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and/or walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
    5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.06 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

3.07 DELIVERY, STORAGE AND HANDLING

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
    1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Products and/or materials that become damaged due to water, dirt, and/or dust as a result of improper storage and handling to be replaced before installation.
    2. Protect equipment to avoid damage. Close conduit openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.

3. Protect bus duct and similar items until in service.

3.08 DEMONSTRATION

A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 08 00, Commissioning of Electrical and individual Division 26, Electrical Sections.

B. Upon completion of work and adjustment of equipment, test systems and demonstrate to Owner's Representative, Architect, and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.09 CLEANING

A. Confirm Cleaning requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Upon completion of installation, thoroughly clean electrical equipment, removing dirt, debris, dust, temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.10 INSTALLATION

A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

D. Provide miscellaneous supports/metals required for installation of equipment.

3.11 PAINTING

A. Confirm requirements in Division 01, General Requirements and Division 09, Finishes. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:

1. Ferrous Metal: After completion of work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces (i.e., hangers, hanger rods, equipment stands, etc.) with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
2. In Electrical Room, on roof or other exposed areas, equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
3. See individual equipment Specifications for other painting.
4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
5. Conduit: Clean, primer coat and paint interior/exterior conduit exposed in public areas with two coats paint suitable for metallic surfaces. Color selected by Architect.
6. Covers: Covers such as manholes, vaults and the like will be furnished with finishes which resist corrosion and rust.

3.12 ACCESS PANELS

A. Confirm Access Panel requirements in Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:
   1. Coordinate locations/sizes of access panels with Architect prior to work.

3.13 DEMOLITION

A. Confirm requirements in Division 01, General Requirements and Division 02, Existing Conditions. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
   1. It is the intent of these documents to provide necessary information and adjustments to electrical system required to meet code, and accommodate installation of new work.
   2. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas. Owner will cooperate to best of their ability to assist in coordinated schedule, but will remain final authority as to time of work permitted.
   3. Examination:
      a. Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to locate and preserve utilities. Replace damaged items with new material to match existing.
      b. Verify that abandoned wiring and equipment serve only abandoned facilities.
      c. Demolition drawings are based on casual field observation and existing record documents.
         1) Verify accuracy of information shown prior to bidding and provide such labor and material as is necessary to accomplish work.
         2) Verify location and number of electrical outlets, luminaires, panels, etc. in field.
      d. Report discrepancies to Architect before disturbing existing installation.
         1) Promptly notify Owner if utilities are found which are not shown on Drawings.
   4. Execution:
      a. Remove existing luminaires, switches, receptacles, and other electrical equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless shown as retained or relocated on Drawings.
      b. Provide temporary wiring and connections to maintain electrical continuity of existing systems during construction. Remove or relocate electrical boxes, conduit, wiring, equipment, and luminaires, as encountered in removed or remodeled areas in existing construction affected by this work.
      c. Remove and restore wiring which serves usable existing outlets clear of construction or demolition.
      d. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, provide new conduit and wire to bypass inaccessible junction boxes and abandoned outlets.
      e. If existing conduits pass through partitions or ceiling which are being removed or remodeled, provide new conduit and wire to reroute clear of construction or demolition and maintain service to existing load.
      f. Extend circuiting and devices in existing walls to be furred out.
      g. Remove abandoned wiring to source of supply.
      h. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
      i. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
      j. Disconnect and remove abandoned panelboards and distribution equipment.

k. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
l. Existing lighting which is to remain, leave luminaires in proper working order.
m. Repair adjacent construction and finishes damaged during demolition work.
n. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

3.14 ACCEPTANCE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
a. Cleaning
b. Operation and Maintenance Manuals
c. Training of Operating Personnel
d. Record Drawings
e. Warranty and Guaranty Certificates
f. Start-up/Test Document and Commissioning Reports

3.15 FIELD QUALITY CONTROL

A. Confirm Field Quality Control requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Tests:
1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in operation and maintenance manuals.
2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.16 LETTER OF CONFORMANCE

A. Provide Letter of Conformance, copies of manufacturers' warranties and extended warranties with a statement that Electrical items were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include Letter of Conformance, copies of manufacturers' warranties and extended warranties in Operation and Maintenance Manuals.

3.17 SALVAGED EQUIPMENT AND RECYCLED MATERIAL

A. Salvage the following equipment not being reused and return to Owner:
1. Panelboards
2. Breakers

B. Electrical equipment that cannot be salvaged for reuse sell/give to recycling company. Recycle following excess, removed, or demolished electrical material:
1. Copper or aluminum conductors, buses, and motor/transformer windings.
2. Steel and aluminum from raceways, boxes, enclosures, and housings.
3. Acrylic and glass from luminaire lenses/refractors.

C. Provide separate on-site storage space for recycled, recycled and salvaged, or salvaged material. Clearly label space.

D. Confirm additional salvaged equipment and recycled materials in the Contract Documents.

END OF SECTION

SECTION 26 0509
EQUIPMENT WIRING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Equipment connections, whether furnished by Owner or other Divisions of the Contract.
   2. Equipment grounding.

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition:
   1. Verify mechanical and utilization equipment electrical characteristics with Drawings and equipment submittals prior to ordering equipment. Submit confirmation of this verification as a part of, or addendum to, the electrical product submittals.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials and Equipment for Equipment Wiring: As specified in individual Sections.

2.02 GENERAL

A. Unless otherwise noted, the following voltage and phase characteristics apply to motors:
   1. 3/4 HP and Under: 120 volt, 1 phase.
   2. 1 HP and Over: 208 volt, 3 phase.
   3. 1 HP and Over: 480 volt, 3 phase.

B. Safety Switches: Provide as required by OESC and as specified in Section 26 28 16, Enclosed Switches and Circuit Breakers.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to submittal of product data for electrical distribution equipment, obtain and examine product data and shop drawings for equipment furnished by the Owner and by other trades on the project. Update the schedule of equipment electrical connections accordingly, noting proper ratings for overcurrent devices, fuses, safety disconnect switches, conduit and wiring, and the like. As a minimum, this requirement applies to equipment furnished by Owner and equipment furnished under the following divisions of work under this contract:
   1. Division 10, Specialties
   2. Division 11, Equipment
   3. Division 14, Conveying Equipment
   4. Division 21, Fire Suppression

5. Division 22, Plumbing
6. Division 23, HVAC, Heating, Ventilating and Air Conditioning
7. Division 27, Communications
8. Division 28, Electronic Safety and Security

3.02 INSTALLATION

A. Do not install unrelated electrical equipment or wiring on mechanical equipment without prior approval of Engineer.

B. Provide moisture tight equipment wiring and switches in ducts or plenums used for environmental air.

C. Connect motor and appliance/utilization equipment complete from panel to motor/equipment as required by code.

D. Install motor starters and controllers for equipment furnished by others.

E. Appliance/Utilization Equipment:
   1. Provide appropriate cable and cord cap for final connection unless equipment is provided with same. Provide receptacle configured to receive cord cap.
   2. Verify special purpose outlet NEMA configuration and ampere rating with equipment supplier prior to ordering wiring devices and coverplates.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Division 01, General Requirements.

3.04 SYSTEMS STARTUP

A. Provide field representative to prepare and start equipment.
   1. Test and correct for proper rotation of polyphase motors.

B. Adjust for proper operation within manufacturer's published tolerances.

C. Demonstrate proper operation of equipment to Owner's designated representative.

END OF SECTION

SECTION 26 0519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Wires and Cables
   2. Connectors
   3. Lugs and Pads

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Cable insulation test reports in project closeout documentation.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Wires and Cables:
   1. Carol
   2. General Cable
   3. Okonite
   4. Southwire
   5. Alcan/Stabiloy
   6. Nexans/Energex 8000
   7. Raychem
   8. Or approved equivalent.

B. Connectors:
   1. Stranded conductors by Anderson.
   2. Burndy
   3. Ilsco
   4. 3M
   5. Thomas & Betts
   6. Or approved equivalent.

C. Splices:
   1. Branch Circuit Splices:
      a. Ideal
      b. Scotch-Lock
      c. 3M
      d. Or approved equivalent.

2. Feeder Splices:
   a. Compression barrel splice with two layers Scotch 23 and four layers of Scotch 33+ as vapor barrier.

D. Metal Clad Cable - Type MC:
1. Alflex
2. AFC
3. Carol
4. Southwire
5. Or approved equivalent.

E. Connectors:
1. Construction:
   a. T & B Series 60200
   b. Or approved equivalent.
2. Oxide-Inhibiting Joint Compounds:
   a. PENETROX A-13
   b. Or approved equivalent.
3. Fluorescent Luminaire Disconnect:
   a. Thomas & Betts Sta-Kon
   b. Lithonia
   c. Or approved equivalent.

F. Lugs:
1. Anderson
2. Ilsco
3. Panduit
4. Thomas & Betts
5. 3M
6. Or approved equivalent.

2.02 WIRES AND CABLES

A. Copper, 600 volt rated throughout. Conductors 12 AWG and 10 AWG, stranded. Conductors 8 AWG and larger, stranded. 12 AWG minimum conductor size. Minimum insulation rating of 90 degrees C. Insulation Type: THWN-2, XHHW-2 or THHN-2.

B. Phase color to be consistent at feeder terminations; A-B-C, top to bottom, left to right, front to back.

C. Color Code Conductors as Follows:

PHASE	208 VOLT WYE	480 VOLT
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green
Switch Legs	Pink	N/A
Travelers	Purple	N/A

D. MC Cable: High strength galvanized steel flexible armor. Allowed only when spare conductor is provided in cable. Full length minimum size No. 12 copper ground wire, THHN 90C conductors, full length tape marker phase/circuit identification on cable armor.

2.03 CONNECTORS

A. Copper Pads: Drilled and tapped for multiple conductor terminals.

B. Lugs: Compression type for use with stranded branch circuit or control conductors; mechanical lugs for use with solid branch and feeder circuit conductors.

C. Split bolt connectors not allowed.

D. Conductor Branch Circuits: Wire nuts with integral spring connectors for conductors 12 AWG through 8 AWG. Push-in type connectors where conductors are not required to be twisted together are not acceptable.

E. Fluorescent Luminaire Disconnect: polycarbonate housing, tin-plated brass contacts, insulated 18 AWG, factory-installed solid copper leads, 105C temperature rating, UL94-V2 flammability, 4A, 600V. NEC Article 410 compliant. Finger-safe line side. Push-and-click connector.

2.04 LUGS AND PADS

A. Ampacity: Cross-Sectional area of pad for multiple conductor terminations to match ampere rating of panelboard bus or equipment line terminals.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Wires and Cables:
   1. Conductor Installation:
      a. Install conductors in raceways having adequate, code size cross-Sectional area for wires indicated.
      b. Install conductors with care to avoid damage to insulation.
      c. Do not apply greater tension on conductors than recommended by manufacturer during installation.
      d. Use of pulling compounds is permitted. Clean residue from exposed conductors and raceway entrances after conductor installation. Do not use pulling compounds for installation of conductors connected to GFCI circuit breakers or GFCI receptacles.
   2. Provide dedicated neutrals (one neutral conductor for each phase conductor) in all 120V circuits
   3. Conductors in Cabinets:
      a. Cable and tree wires in panels and cabinets for power and control. Use plastic ties in panels and cabinets.
      b. Tie and bundle feeder conductors in wireways of panelboards.
      c. Hold conductors away from sharp metal edges.
   4. Homeruns:
      a. Do not change intent of branch circuit homeruns without approval. Homeruns for 20A branch circuits may be combined to a maximum of six current carrying conductors including neutral conductors in homeruns. Apply derating factors as required per NEC. Increase conductor size as needed.
   5. Identify wire and cable under the provisions of Section 26 05 53, Identification for Electrical Systems. Identify each conductor with its panel and circuit number as indicated.
   6. Use of MC Cable is limited to the following conditions. Installations that do not comply with the following conditions are to be removed and replaced with no additional expense to the Owner.
      a. 20 and 30 amp branch wiring where following conditions apply:
         1) Where there is a suspended ceiling with accessible space above (example: suspended acoustic ceiling tile).
         2) For drops to ceiling mounted luminaires in areas with accessible ceiling space.
         3) In residential units where allowed by the NEC.
         4) Do not use for homeruns from branch circuit panel to first device or luminaire in circuit.
         5) Do not use in walls in areas where MC cable cannot be fished into the walls after construction is completed. For example: walls with glazing or solid beams overhead, partial height walls, etc.
         6) No single run of MC cable longer than 50-feet.

7. Exposed cable is not allowed. or allowed in the following locations:
8. Exposed cable must be run parallel or perpendicular to building lines and hidden from view when possible.

3.02 FIELD QUALITY CONTROL

A. Test conductor insulation on feeders of 100 amp and greater for conformity with 1000 volt megohmmeter. Use Insulated Cable Engineers Association testing procedures. Minimum insulation resistance acceptable is 1 megohm for systems 600 volts and below. Notify Architect if insulation resistance is less than 1 megohm.

B. Test Report: Prepare a typed tabular report indicating the testing instrument, the feeder tested, amperage rating of the feeder, insulation type, voltage, the approximate length of the feeder, conduit type, and the measured resistance of the megohmmeter test. Submit test reports with project closeout documents.

C. Inspect and test in accordance with NETA Standard ATS, except Section 4.

D. Perform inspections and tests listed in NETA Standard ATS, Section 7.3.2.

END OF SECTION

SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Connectors and Accessories
   2. Grounding Busbar
   3. Grounding Conductor

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Test reports of ground resistance for service and separately derived system grounds.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Comply with the requirements of ANSI/NFPA 70.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Grounding Connectors:
   1. Burndy Hyground Compression System
   2. Erico/Cadweld
   3. Amp Ampact Grounding System
   4. Or approved equivalent.

B. Pipe Grounding Clamp:
   1. Burndy GAR Series
   2. O Z Gedney
   3. Thomas & Betts
   4. Or approved equivalent.

C. Grounding Busbar:
   1. Chatsworth
   2. Erico
   3. Square D
   4. Panduit
   5. Or approved equivalent.

2.02 CONNECTORS AND ACCESSORIES

A. Grounding Connectors: Hydraulic compression tool applied connectors or exothermic welding process connectors or powder actuated compression tool applied connectors.

B. Pipe Grounding Clamp: Mechanical ground connector with cable parallel or perpendicular to pipe.

2.03 GROUNDING BUSBAR

A. Grounding Busbar: 1/4-inch thick by 4-inch high by 10-inch long copper grounding busbar with insulators that meet ANSI J-STD-607-A specifications. UL 467 listed. Hole patterns in busbar to accommodate two-hole lugs, four-hole configuration.

2.04 GROUNDING CONDUCTOR

A. Grounding Electrode Conductor: Soft-draw bare stranded copper for wire sizes larger than #10 AWG Bare. Solid copper for wire sizes #10 AWG and smaller.

B. Equipment Grounding Conductor: Green insulated, insulation type to match that of associated feeder or branch circuit wiring, size as indicated on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify site conditions prior to beginning work.

B. Verify that final backfill and compaction have been completed before driving rod electrodes.

3.02 INSTALLATION

A. Other Metal Piping Systems: Bond gas piping system, fire sprinkler piping system and other metal piping systems to service equipment ground bus or to the grounding electrode system.

B. Raceways:
   1. Ground metallic raceway systems. Bond to ground terminal with code size jumper except where code size or larger equipment grounding conductor is included with circuit, use grounding bushing with lay-in lug.
   2. Connect metal raceways, which terminate within an enclosure but without mechanical connection to enclosure, by grounding bushings and ground conductor to grounding bus.
   3. Where equipment supply conductors are in flexible metallic conduit, install stranded copper equipment grounding conductor from outlet box to equipment frame.
   4. Install equipment grounding conductor, code size minimum unless noted on drawings, in metallic and nonmetallic raceway systems.

C. Feeders and Branch Circuits:
   1. Provide continuous green insulated copper equipment grounding conductors for feeders and branch circuits.
   2. Where installed in a continuous solid metallic raceway system and larger sizes are not detailed, provide insulated equipment grounding conductors for feeders and branch circuits sized in accordance with the latest adopted edition of NEC Article 250, Table 250-122.

D. Boxes, Cabinets, Enclosures and Panelboards:
   1. Bond equipment grounding conductors to enclosure with specified conductors and lugs. Install lugs only on thoroughly cleaned contact surfaces.
   2. Bond Sections of service equipment enclosure to service ground bus.

E. Motors, Equipment and Appliances: Install code size equipment grounding conductor to (motor) equipment frame or manufacturer's designated ground terminal.

F. Receptacles: Connect ground terminal of receptacle and associated outlet box to equipment grounding conductor. Self grounding nature of receptacle devices does not eliminate equipment grounding conductor bolted to outlet box.

G. Separately Derived Systems: Ground each separately derived system per NEC Article 250.

H. Install ground grid under access floors where indicated. Construct grid of #2 AWG bare copper stranded wire installed on 24-inch centers both ways. Bond each access floor pedestal to grid

I. Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Use #2 AWG bare copper conductor.

J. Corrosion inhibitors: Apply a corrosion inhibitor to contact surfaces when making grounding and bonding connections. Use corrosion inhibitor appropriate for protecting a connection between metals used.

3.03 FIELD QUALITY CONTROL

A. Grounding system resistance to ground not to exceed 5 ohms. Make necessary modifications or additions to grounding electrode system for compliance. Submit final tests to assure that this requirement is met.

B. Resistance of grounding electrode system: measure using a four-terminal fall-of-potential method as defined in IEEE 81. Take ground resistance measurements before electrical distribution system is energized and in normally dry conditions, not less than 48 hours after last rainfall. Take resistance measurements of separate grounding electrode systems before systems are bonded together below grade. Combined resistance of separate systems may be used to meet required resistance, but specified number of electrodes must still be provided.

C. Inspect and test in accordance with NETA Standard ATS, Except Section 4.

D. Perform inspections and tests listed in NETA Standard AB, Section 7.13.

END OF SECTION

SECTION 26 0529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Hangers, Supports, Anchors, Threaded Rod and Fasteners
   2. Support Channel
   3. Rooftop Conduit Supports

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. Submittals not required for this Section.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems, whose products have been in satisfactory use in similar service for not less than 10 years.
   2. Support systems to be supplied by a single manufacturer.
   3. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, equipment hangers/supports, and seismic restraint by a qualified Structural Professional Engineer.
      a. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.07 PERFORMANCE REQUIREMENTS

A. General: Provide conduit and equipment hangers and supports in accordance with the following:
   1. When supports, anchorages, and seismic restraints for equipment and supports, anchorages and seismic restraints for conduit, cable tray and equipment are not shown on the Drawings, the Contractor is responsible for their design.
   2. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Engineered Support Systems: The following support systems to be designed, detailed, and bear the seal of a professional engineer registered in the State of Oregon.
   1. Support frames such as conduit racks or stanchions for conduit and equipment which provide support from below.
   2. Equipment and piping support frame anchorage to supporting slab or structure.

C. Provide channel support systems, for conduits to support multiple conduits capable of supporting combined weight of support systems and system contents.

D. Provide heavy-duty steel trapezes for piping to support multiple conduit capable of supporting combined weight of supported systems and system contents.

E. Provide seismic restraint hangers and supports for conduit and equipment.

F. Obtain approval from AHJ for seismic restraint hanger and support system to be installed for piping and equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Support Channel:
   1. B-Line
   2. Kindorf
   3. Superstrut
   4. Unistrut
   5. Or approved equivalent.

B. Anchors:
   1. Anchor It
   2. Epcon System
   3. Hilti-Hit System
   4. Power Fast System
   5. Or approved equivalent.

C. Rooftop Supports:
   1. Cooper B-Line Dura-Block Rooftop Support Base
   2. Or approved equivalent.

2.02 MATERIALS

A. Hangers, Supports, Anchors, Threaded Rod and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
   1. Channel Material: Carbon steel.
   2. Coating: Hot dip galvanized.

B. Concrete Inserts: Cast in concrete for support fasteners for loads up to 800 lbs.

C. Pipe Straps: Two-hole galvanized or malleable iron.

D. Luminaire Chain: 90 lb. test with steel hooks.

E. Anchor Bolts for Area Luminaire Poles: As supplied by area luminaire pole manufacturer.

F. Anchors and Fasteners:
   1. Do not use powder-actuated anchors.
   2. Obtain permission from Architect before using powder-actuated anchors.
   3. Concrete Structural Elements: Use precast inserts.
   4. Steel Structural Elements: Use beam clamps.
   5. Concrete Surfaces: Use self-drilling anchors.
   6. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.
   7. Solid Masonry Walls: Use expansion anchors.
   8. Sheet Metal: Use sheet metal screws.
   9. Wood Elements: Use wood screws.

G. Rooftop Conduit Supports:
   1. Curb base made of 100 percent recycled rubber and polyurethane prepolymer with a uniform load
   2. Capacity of 500 pounds per linear foot of support.
   3. UV resistant.

4. Steel Frame: Steel, 14 gauge strut galvanized per ASTM A653 or 12 gauge strut galvanized per ASTM A653 for bridge series.
5. Continuous block channel supports with 1-inch gaps to allow water flow, bridge channel supports, extendable height channel supports and elevated single conduit supports.
6. Attaching Hardware: Zinc-plated threaded rod, nuts and attaching hardware per ASTM B633 fastened directly into rubber material with weather resistant Type 12 lag screws.
7. Provide load distribution plates when required for heavy loads.
8. Finish: Black with safety yellow striping.

2.03 MISCELLANEOUS METAL

A. Miscellaneous Metal: Provide miscellaneous metal items specified hereunder, including materials, fabrication, fastenings and accessories required for finished installation, where indicated on Drawings or otherwise not shown on drawings that are necessary for completion of the project. The Contractor is responsible for their design.
   1. Fabricate miscellaneous units to size shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.

B. Structural Shapes: Where miscellaneous metal items are needed to be fabricated from structural steel shapes and plates, provide members constructed of steel conforming with requirements of ASTM A36 or approved equivalent.

C. Steel Pipe: Provide seamless steel pipe conforming to requirements of ASTM A53, Type S, Grade A, or Grade B. Weight and size required as specified.

D. Fasteners: Provide fasteners of types as required for assembly and installation of fabricated items; surface-applied fasteners are specified elsewhere.

E. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.

F. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.

G. Provide hot dipped galvanized components for items exposed to weather.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.

B. Safety factor of 4 required for every fastening device or support for electrical equipment installed. Supports to withstand four times the weight of equipment it supports.

C. Verify mounting height of luminaires prior to installation when heights are not detailed.

D. Install vertical support members for equipment and luminaires, straight and parallel to building walls.

E. Install horizontal support members straight and parallel to ceilings or finished floor unless otherwise noted.

F. Provide independent supports to structural member for electrical luminaires, materials, or equipment installed in or on ceiling, walls or in void spaces or over suspended ceilings.

G. Do not use other trade's fastening devices as supporting means for electrical luminaires, equipment or materials.

H. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

I. Do not use supports or fastening devices to support other than one particular item.

J. Support conduits within 18-inches of outlets, boxes, panels, cabinets and deflections unless more stringently required by NEC.

K. Maximum distance between supports not to exceed 8 foot spacing unless otherwise required by NEC.

L. Support flexible conduits and metal clad cable within 12-inches of outlets, boxes, panels, cabinets and deflections unless otherwise required by NEC.

M. Maximum distance between supports for flexible conduits and metal clad cable not to exceed 48-inches spacing unless otherwise required by NEC.

N. Maximum distance between supports for rigid PVC conduits unless otherwise required by NEC is as follows:
   1. 1/2-inch or 3/4-inch and 1-inch conduit, 3-feet apart.
   2. 1-1/4-inch or 1-1/2-inch and 2-inch conduit, 4-feet apart.
   3. 2-1/2-inch and 3-inch conduit, 5-feet apart.
   4. 4-inch and 5-inch conduit, 6-feet apart.
   5. 6-inch conduit, 7-feet apart.

O. Maximum distance between supports for auxiliary gutters and wireways unless otherwise required by NEC is as follows:
   1. Sheet metal auxiliary gutters and wireways - 4-feet apart horizontally and 10-feet vertically.
   2. Non-metallic auxiliary gutters and wireways - 30-inches apart horizontally and 3-feet vertically.

P. Install strut hangers as instructed by strut manufacturer. Suspended strut hangers as instructed by strut manufacturer for the load, with a maximum spacing of 8-feet on center and within 2-feet of outlet box, cabinet, junction box or other channel raceway termination unless otherwise required by NEC.

Q. Coordinate routing of conduit racks with materials and equipment installed by other trades. Where conduit racks are exposed to view, coordinate location and installation with Architect for optimal appearance.

R. Securely suspend junction boxes, pull boxes or other conduit terminating housings located above suspended ceiling from floor above or roof structure to prevent sagging and swaying.

S. Provide seismic bracing per UBC requirements.

T. Where service disconnects are mounted on building exterior, physically attach service disconnect to the building or structure served.

U. Install surface-mounted cabinets and panelboards with minimum of four anchors.

V. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

W. Use spring lock washers under fastener nuts for strut.

3.02 CUTTING AND DRILLING

A. Do not drill or cut structural members without prior permission from Architect.

3.03 WET AND DAMP LOCATIONS

A. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1-inch off wall.

3.04 ROOFTOP SUPPORTS

A. Consult roofing manufacturer for roof membrane compression capacities. If necessary, provide a compatible sheet of roofing material (rubber pad) under rooftop support to disperse concentrated loads and add further membrane protection.

B. Do not use supports that will void roof warranty.

C. Install supports per manufacturers instructions and recommendations.

D. Use properly sized clamps to suit conduit sizes.

E. Install supports for rooftop raceways to raise raceways a minimum of 4-inches above the roof structure unless otherwise noted.

3.05 FABRICATION - MISCELLANEOUS METALS

A. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on Drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates, and similar devices. Hot dipped galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.

B. Finishes:
   1. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with one coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas in primer with same material, before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.
   2. Metal in contact with Concrete, Masonry and Other Dissimilar Materials: Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
   3. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

END OF SECTION

SECTION 26 0533
RACEWAYS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Rigid Metal Conduit (RMC)
   2. Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit
   3. Electrical Metallic Tubing (EMT)
   4. Flexible Metal Conduit (FMC)
   5. Liquidtight Flexible Metal Conduit (LFMC)
   6. Electrical Polyvinyl Chloride (PVC) Conduit
   7. Conduit Fittings

B. Provide a complete system of conduit and fittings, with associated couplings, connectors, and fittings, as shown on drawings and described in these specifications.

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
   1. Section 26 05 29, Hangers and Supports for Electrical Systems and Equipment
   2. Section 26 05 34, Boxes

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.07 DEFINITIONS

A. Raceway system is defined as consisting of conduit, tubing, duct, and fittings including but not limited to connectors, couplings, offsets, elbows, bushings, expansion/deflection fittings, and other components and accessories. Complete electrical raceway installation before starting the installation of conductors and cables.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Rigid Metal Conduit (RMC):
   1. Allied Tube & Conduit
   2. Beck Manufacturing Inc.
   3. Picoma
   4. Wheatland Tube Company
   5. Or approved equivalent.

B. Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit:
   1. Allied Tube & Conduit
   2. Thomas & Betts Corporation

3. Robroy Industries
4. Or approved equivalent.

C. Electrical Metallic Tubing (EMT):
1. Allied Tube & Conduit
2. Beck Manufacturing WL
3. Picoma
4. Wheatland Tube Company
5. Or approved equivalent.

D. Flexible Metal Conduit (FMC):
1. AFC Cable Systems Inc.
2. Electri-Flex Company
3. International Metal Hose
4. Or approved equivalent.

E. Liquidtight Flexible Metal Conduit (LFMC):
1. AFC Cable Systems Inc.
2. Electri-Flex Company
3. International Metal Hose
4. Or approved equivalent.

F. Electrical Polyvinyl Chloride (PVC) Conduit:
1. AFC Cable Systems Inc.
2. Electri-Flex Company
3. International Metal Hose
4. JM Eagle
5. Or approved equivalent.

G. Conduit Fittings:
1. Bushings:
a. Insulated Type for Threaded Rigid IMC Conduit Without Factory Installed Plastic Throat Conductor Protection:
1) Thomas & Betts 1222 Series
2) O-Z Gedney B Series
3) Or approved Equivalent.
2. Insulated Grounding Type for Threaded Rigid IMC Conduit:
a. O-Z Gedney BLG Series
b. Or approved Equivalent.
3. Expansion/Deflection Fittings:
a. EMT, O-Z Gedney Type TX
b. RMC, O-Z Gedney Type AX, DX and AXDX, Crouse & Hinds XD
c. Or approved equivalent.

2.02 RIGID METAL CONDUIT (RMC)

A. UL 6, ANSI C80.1. Hot dipped galvanized steel conduit after thread cutting.
1. Fittings: NEMA FB2.10.

2.03 PVC EXTERNALLY COATED GALVANIZED RIGID STEEL CONDUIT

A. Description: NEMA RN 1; rigid steel conduit with external PVC coating.

B. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.04 ELECTRICAL METALLIC TUBING (EMT)

A. Description: UL 797, ANSI C80.3; steel galvanized tubing.

B. Fittings: NEMA FB 1; steel, compression type.

2.05 FLEXIBLE METAL CONDUIT (FMC)

A. Description: UL 1, Interlocked steel construction.

B. Fittings: NEMA FB 2.20.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: UL 360, inner core made from spiral wound strip of heavy gauge, hot dipped galvanized low carbon steel. 1/2-inch through 1-1/4-inch trade sizes have a square lock core and contain an integral bonding strip of copper. 1-1/2-inch and larger have fully interlocked core. Jacket material is moisture, oil and sunlight resistant flexible PVC.

B. Fittings: NEMA FB 2.20.

2.07 ELECTRICAL POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: UL 651, NEMA TC 2; Schedule 40 PVC.

B. Fittings: NEMA TC 3.

2.08 CONDUIT FITTINGS

A. Bushings:
   1. Insulated type for threaded rigid IMC conduit without factory installed plastic throat conductor protection.
   2. Insulated grounding type for threaded rigid IMC conduit.

B. Raceway Connectors and EMT Couplings:
   1. Steel connectors, couplings, and conduit bodies, with hot-dip galvanized.
   2. Connector locknuts are steel, with threads meeting ASTM tolerances. Locknuts are hot-dip galvanized.
   3. Connector throats (EMT, flexible conduit, metal clad cable and cordset connectors) have factory installed plastic inserts permanently installed. For normal cable or conductor exiting angles from raceway, the cable jacket or conductor insulation bears only on plastic throat insert.
   4. Steel gland, Tomic or Breagle connectors and couplings are recognized for this Contract as having acceptable raceway to fitting electrical conductance.
   5. Set screw connectors and couplings, without integral compression glands, are recognized for this contract as not having acceptable raceway to fitting electrical conductance. A ground conductor sized per this Specification must be included and bonded within raceway assembly utilizing this type connector or coupling.

C. Provide expansion/deflection fittings for EMT.

PART 3 - EXECUTION

3.01 SEQUENCING AND SCHEDULING

A. Finished Surfaces: Schedule raceway installation to avoid conflict with installed wall and ceiling surfaces. If unavoidable, coordinate work and repairs with Architect.

3.02 CONDUIT REQUIREMENTS

A. Conduit Size:
   1. Minimum Size: 3/4-inch for power and control, unless otherwise noted. 3/4-inch for communication/data, unless otherwise noted. 3/4-inch for signal systems, unless otherwise noted.

B. Underground Installations:
   1. More than 5-feet from Foundation Wall: Use PVC.
   2. Within 5-feet from Foundation Wall: Use PVC coated RMC.
   3. In or Under Slab on Grade: Use PVC.
   4. Minimum Size: 1-inch.
   5. RMC stubs at a minimum of 6 inches below grade to a minimum of 36 inches above grade.

C. Outdoor Locations Above Grade: Use RMC. RMC stubs at a minimum of 6 inches below grade to a minimum of 36 inches above grade.

D. In Slab Above Grade:
   1. Not allowed.

E. Damp Locations: EMT up to 2-inches in diameter.

F. Dry Locations:
   1. Concealed: EMT.
   2. Exposed: RMC.

G. Dry, Protected: EMT.

H. In areas exposed to severe mechanical damage: RMC.

I. For security conduits installed exposed and subject to tampering: RMC.

J. In hazardous areas per NEC 501: RMC.

K. Provide two pull strings/tapes in empty conduits. Types:
   1. Utility Company Conduit: Polyester measure/pulling tape, Greenlee 4436 or approved equivalent. Coordinate exact requirements with utility company.
   2. Feeders: Polyester measure/pulling tape, Greenlee 4436 or approved.
   3. Branch circuits and low voltage: Greenlee Poly Line 431 or approved.
   4. If fish tape is used for pulling line or low voltage wiring, fiberglass type to be used. Metal fish tapes will not be allowed.
   5. Secure pull string/tape at each end.
   6. Provide caps on ends of empty conduit to be used in future.
   7. Label both ends of empty conduits with location of opposite end.

L. Elbows: Fiberglass or PVC coated RMC acceptable for underground installations.

M. Elbow for Low Energy Signal Systems: Use long radius factory ells where linking sections of raceway for installation of signal cable.

N. Elbow for Medium Voltage Systems: Use long radius factory ells where linking sections of raceway per NEC Article 300.34.

O. Use PVC coated RMC 36-inch radius ells for power service conduits and 48-inch radius ells for telephone service conduits.

P. For Dry Areas: Motors, recessed luminaires and equipment connections subject to movement or vibration, use flexible metallic conduit.

Q. Motors and equipment connections subject to movement or vibration and subjected to any of following conditions; exterior location, moist or humid atmosphere, water spray, oil, or grease use PVC coated liquidtight flexible metallic conduit.

3.03 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Plan locations of conduit runs in advance of the installation and coordinate with ductwork, plumbing, ceiling and wall construction in the same areas.

C. Locate penetrations and holes in advance where they are proposed in the structural sections such as footings, beams, and walls. Penetrations are acceptable only when the following occurs:
   1. Where shown on the structural drawings.
   2. As approved by the Structural Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.

D. Verify routing and termination locations of conduit prior to rough-in.

E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.04 INSTALLATION

A. Install raceways securely, in neat and workmanlike manner, as specified in NECA 1, Standard Practices for Good Workmanship in Electrical Construction.

B. Install steel conduit as specified in NECA 101, Standard for Installing Steel Conduits.

C. Install nonmetallic conduit in accordance with manufacturer's instructions.

D. Inserts, anchors and sleeves.
   1. Coordinate location of inserts and anchor bolts for electrical systems prior to concrete pour.
   2. Coordinate location of sleeves with consideration for other building systems prior to concrete pour.

E. Conduit Supports:
   1. Arrange supports to prevent misalignment during wiring installation.
   2. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
   3. Group related conduits; support using conduit rack. Construct rack using steel channel. Provide space on each for 25 percent additional conduits.
   4. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
   5. Do not attach conduit to ceiling support wires.

F. Flexible steel conduit length not-to-exceed 6-feet, 3-feet in concealed walls. Provide sufficient slack to reduce the effect of vibration.

G. Install conduit seals at boundaries where ambient temperatures differ by 10 degrees F or more as shown on the drawings. Install seals on warm side of partition.

H. Seal raceways stubbing up into electrical equipment. Plug raceways with conductors with duct-seal. Cap spare raceways and plug PVC raceway products with plastic plugs as made by Underground Products, or equal, shaped to fit snugly into the stubup.

I. Seal raceways penetrating an exterior building wall to prevent moisture and vermin from entering into the electrical equipment.

J. Use suitable caps on spare and empty conduits to protect installed conduit against entrance of dirt and moisture.

K. Only conduit servicing elevator equipment can be installed through elevator shafts or equipment rooms. These conduits may only enter the room and go directly to the equipment being supplied.

L. Keep emergency system wiring independent of other wiring systems per NEC 700.

M. Installation of conduit in structural concrete that is less than 3-inches thick is prohibited without the approval of the Structural Engineer. Maintenance pads, and curbs are exempted.

N. Conduit Joints: Assemble conduits continuous and secure to boxes, panels, luminaires and equipment with fittings to maintain continuity. Provide watertight joints where embedded in concrete, below grade or in damp locations. Seal PVC conduit joints with solvent cement and metal conduit with metal thread primer. Rigid conduit connections to be threaded, clean and tight (metal to metal). Threadless connections are not permitted for RMC and IMC. Seal conduits where penetrating below raised floor area.

O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

P. Arrange conduit to maintain headroom and present neat appearance.

Q. Do not install conduits on surface of building exterior, along vapor barrier, across roof, on top of parapet walls, or across floors, unless otherwise noted on drawings.

R. Exposed conduits are permitted only in following areas:

1. Mechanical rooms, electrical rooms or spaces where walls, ceilings and floors will not be covered with finished material.
2. Existing walls that are concrete or block construction.
3. Where specifically noted on Drawings.

S. Do not install conduits or other electrical equipment in obvious passages, doorways, scuttles or crawl spaces which would impede or block area passage's intended usage.

T. Install continuous conduit and raceways for electrical power wiring and signal systems wiring.

U. Below Grade Conduit:
1. Place minimum 3-inch cover of sand or clean earth fill around conduit. Lay conduit on smooth level trench bottom, so that contact is made for its entire length.
2. Remove water from trench before conduit is installed.
3. When three or more conduits are in a single trench, use conduit spacers that will maintain 3-inch spacing between conduits. Provide spacers on 5-foot centers.
4. Provide PVC coated galvanized rigid conduit for elbows larger than 30 degrees or 1-inch diameter.
5. Provide trenching, backfilling, compaction, repaving or other site restoration as required by work done in this division.
6. Slope underground conduits which enter building to drain away from building and to be water sealed to prevent moisture from passing through conduit into building. Joints threaded and taped or glued to prevent entry of water into conduits.
7. Provide watertight conduit sleeves and rubber seals for conduit entering building below grade, Link-Seal system by Thunderline Corporation or approved equivalent.

V. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

W. Maintain adequate clearance between conduit and piping.

X. Keep conduits a minimum of 12-inches away from steam or hot water radiant heating lines (at or above 104 degrees F) or 3-inches away from waste or water lines.

Y. Cut conduit square using saw or pipecutter; deburr cut ends.

Z. Bring conduit to shoulder of fittings; fasten securely.

AA. Use conduit hubs to fasten conduit to cast boxes in damp and wet locations.

AB. Install no more than the equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate factory elbows for bends in metal conduit larger than 2-inch size.

AC. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

AD. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control, and expansion joints.

AE. Conduit Terminations for Signal Systems: Provide a plastic bushing on the end of conduit used for signal system wiring.

AF. Flexible Conduit: Install 12-inch minimum slack loop on flexible metallic conduit and liquidtight flexible metallic conduit.

AG. Feeders: Do not combine or change feeder runs.

3.05 CONDUIT FITTINGS

A. Use set screw type fittings only in dry locations. When set screw fittings are utilized provide insulated continuous equipment ground conductor in conduit, from overcurrent protection device to outlet.

B. Use compression fittings in dry locations, damp and rain-exposed locations. Maximum size permitted in damp locations and locations exposed to rain is 2-inches in diameter.

C. Use threaded type fittings in wet locations, hazardous locations, and damp or rain-exposed locations where conduit size is greater than 2-inches.

D. Use PVC coated RMC 36-inch radius ells for power service conduits and 48-inch radius ells for telephone service conduits.

E. Use insulated type bushings with ground provision at switchboards, panelboards, safety disconnect switches, junction boxes that have feeders 60 amperes and greater.

F. Condulets and Conduit Bodies:
   1. Do not use condulets and conduit bodies in conduits for signal wiring or in feeders 100 amp and larger.
   2. Do not use condulets and conduit bodies.

G. Sleeves and Chases - Floor, Ceiling and Wall Penetrations: Provide necessary rigid conduit sleeves, openings and chases where conduits or cables are required to pass through floors, ceilings or walls.

H. Expansion Joints:
   1. Provide conduits crossing expansion joints where cast in concrete with expansion-deflection fittings, equivalent to OZ/Gedney AXDX, installed per manufacturers recommendations.
   2. Secure conduits 3-inches and larger to building structure on opposite sides of a building expansion joint with an expansion-deflection fitting across joint installed per manufacturer's recommendations.
   3. Provide conduits less than 3-inches where not cast in concrete with junction boxes securely fastened on both sides of expansion joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line length) flexible conduit and copper green ground bonding jumper. In lieu of this flexible conduit, an expansion-deflection fitting, as indicated for conduits 3-inch and larger may be installed.
   4. Verify expansion/deflection requirements with Structural Engineer prior to installation.

I. Seismic Joints:
   1. No conduits cast in concrete allowed to cross seismic joint.
   2. Provide conduits with junction boxes securely fastened on both sides of seismic joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line length) flexible conduit and copper green ground bonding jumper. Prior to installation, verify with Architect that 15-inches is adequate for designed movement, and if not, increase this length as required.
   3. Provide conduits less than 3-inches where not cast in concrete with junction boxes securely fastened on both sides of expansion joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line length) flexible conduit and copper green ground bonding jumper. In lieu of this flexible conduit, an expansion-deflection fitting, as indicated for conduits 3-inch and larger may be installed.

J. Provide rigid conduit coupling flush with surface of slab or wall for conduit stubbed in concrete slab or wall to serve electrical equipment or an outlet under table or to supply shop tool, etc. Provide plug where conduit is to be used in future.

3.06 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07, Thermal and Moisture Protection.

B. Route conduit through roof openings for piping and ductwork wherever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation and installer.

END OF SECTION

SECTION 26 0534
BOXES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Outlet Boxes
   2. Floor Boxes
   3. Pull and Junction Boxes
   4. Box Extension Adapter
   5. Conduit Fittings
   6. Weatherproof Outlet Boxes

B. Provide electrical boxes and fittings for a complete installation. Include but not limited to outlet boxes, junction boxes, pull boxes, bushings, locknuts and other necessary components.

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
   1. Section 26 05 33, Raceways
   2. Section 26 05 53, Identification for Electrical Systems

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Outlet Boxes:
   1. Bowers
   2. Hubbell
   3. Raco
   4. Steel City
   5. Thomas & Betts
   6. Or approved equivalent.

B. Floor Boxes/Poke-Thrus:
   1. Wiremold/Walker
   2. FSR
   3. Hubbell
   4. Steel City
   5. MonoSystems
   6. Or approved equivalent.

C. Pull and Junction Boxes:
   1. B-Line

2. Hoffman
3. Or approved equivalent.

D. Box Extension Adapter:
1. Bell
2. Carlon
3. Raco
4. Red Dot
5. Steel City
6. Thomas & Betts
7. Or approved equivalent.

E. Conduit Fittings:
1. Killark
2. O-Z Gedney
3. Raco
4. Steel City
5. Thomas & Betts
6. Or approved equivalent.

F. Weatherproof Outlet Boxes:
1. Pass and Seymour
2. Bell
3. Red Dot
4. Carlon
5. Or approved equivalent.

2.02 OUTLET BOXES

A. Luminaire Outlet: 4-inch octagonal box, 1-1/2-inches deep with 3/8-inch luminaire stud if required. Provide raised covers on bracket outlets and on ceiling outlets.

B. Device Outlet: Installation of one or two devices at common location, minimum 4-inches square, minimum 1-1/2-inches deep. Single- or two-gang flush device raised covers.

C. Telecom Outlet: Provide 4-inches square, minimum 2-1/8-inch deep box with two-gang plaster ring. Provide under provisions of Division 27, Communications.

D. Multiple Devices: Three or more devices at common location. Install one-piece gang boxes with one-piece device cover. Install one device per gang.

E. Masonry Boxes: Outlets in concrete.

F. Construction: For interior locations, provide galvanized steel outlet wiring boxes, of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.

G. Accessories: Provide outlet box accessories for each installation, including mounting brackets, wallboard hangers, extension rings, luminaire studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations.

H. Noise Control: Provide acoustic putty pad to back side of each outlet box installed in acoustic rated walls.

2.03 FLOOR BOXES AND POKE-THRUS

A. Multi-Gang Box, Slab on Grade: Wiremold RFB4-CI series cast iron housing with S40CC series aluminum finish, steel flanged activation for use with matching carpet or tile insert. Rubber gasket protects interior from water and debris. Provide with two duplex receptacles and blank inserts for two future data outlets. Provide matching carpet or tile insert in activation cover.

B. Multi-Gang Box, Slab above Grade: Wiremold RFB4 series steel housing with S40CC series aluminum finish, steel flanged activation for use with matching carpet or tile insert. Rubber

gasket protects interior from water and debris. Provide with two duplex receptacles and blank inserts for two future data outlets. Provide matching carpet or tile insert in activation cover.

C. Multi-Gang Box, Concrete Finish Floor: Same as above, except use Wiremold S40BB series aluminum finish, steel flanged activation.

D. Provide floor boxes sized minimum 3-7/16-inches deep with 1-inch factory knockouts.

2.04 PULL AND JUNCTION BOXES

A. Construction: Provide ANSI 49 gray enamel painted sheet steel junction and pull boxes, with screw-on covers; of type shape and size, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

B. Location:
1. Provide junction boxes above accessible ceilings for drops into walls for receptacle outlets from overhead.
2. Provide junction boxes and pull boxes to facilitate installation of conductors and limiting accumulated angular sum of bends between boxes, cabinets and appliances to 270 degrees.

C. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
1. Construction: Galvanized cast iron.
2. Cover: Smooth cover with neoprene gasket and stainless steel cover screws.
3. Cover Legend: ELECTRIC.

D. Fiberglass Handholes: Die molded glass fiber hand holes:
1. Cable Entrance: Pre-cut 6- x 6-inch cable entrance at center bottom of each side.
2. Cover: Fiberglass weatherproof cover with nonskid finish.
3. Cover Legend: ELECTRIC.

2.05 BOX EXTENSION ADAPTER

A. Construction: Diecast aluminum.

B. Location: Install over flush wall outlet boxes to permit flexible raceway extension from flush outlet to fixed or movable equipment. Bell 940 Series, Red Dot IHE4 Series.

2.06 CONDUIT FITTINGS

A. Requirements: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and plastic conduit bushings of the type and size to suit each respective use and installation.

2.07 WEATHERPROOF OUTLET BOXES

A. Construction: Provide corrosion-resistant cast metal weatherproof outlet wiring boxes, of the type, shape and size, including depth of box, with threaded conduit ends, cast metal faceplate with spring-hinged waterproof cap suitably configured for each application, including faceplate, gasket, blank plugs and corrosion proof fasteners. Weatherproof boxes to be constructed to have smooth sides, gray finish.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Coordinate locations of floor boxes and wall mounted wiring device boxes with architectural and structural floor plans prior to rough-in.

3.02 INSTALLATION

A. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1, Standard Practice of Good Workmanship in Electrical Construction.

B. Secure boxes rigidly to substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.

C. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.

D. Set wall mounted boxes at elevations to accommodate mounting heights specified in Section.

E. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.
   1. Adjust box locations up to 10-feet if required to accommodate intended purpose.

F. Mount outlet boxes, unless otherwise required by ADA, or noted on drawings, following distances above finished floor:
   1. Control Switches:
      a. 48-inches to the top of outlet box.
      b. 4-inches above top of backsplash at countertops/workstations, not-to-exceed 44-inches above finished floor to the top of outlet box per ADA requirements.
   2. Receptacles: 15-inches to the bottom of outlet box.
   3. Telecom Outlets: 15-inches to the bottom of outlet box. Coordinate with Division 27, Communications.
   4. Other Outlets: As indicated in other Sections of specifications or as detailed on drawings.

G. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

H. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6-inches from ceiling access panel or from removable recessed luminaire.

I. Flush Outlets in Insulated Spaces: Maintain integrity of insulation and vapor barrier.

J. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07, Thermal and Moisture Protection.

K. Coordinate electrical device locations and elevations (switches and receptacles) with architectural drawings to prevent mounting devices in mirrors, back splashes, and behind cabinets.

L. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

M. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices. Adjacent boxes not aligned vertically to be adjusted at no additional cost to Owner.

N. Use flush mounting outlet box in finished areas.

O. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

P. Do not install flush mounting box back-to-back in walls; provide minimum 6-inches separation. Provide minimum 24-inches in acoustic rated walls.

Q. Apply acoustic putty pad on outlet box prior to installation of acoustical blanket.

R. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

S. Use stamped steel bridges to fasten flush mounting outlet box between studs.

T. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

U. Use adjustable steel channel fasteners for hung ceiling outlet box.

V. Do not fasten boxes to ceiling support wires.

W. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12-inches of box.

X. Use gang box where more than one device is mounted together. Do not use Sectional box.

Y. Use gang box with plaster ring for single device outlets.

Z. Use cast outlet box in exterior locations exposed to the weather and wet locations.

AA. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.

AB. Set floor boxes level.

AC. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

AD. Box Color Coding and Marking: Reference Section 26 05 53, Identification for Electrical Systems.

3.03 ADJUSTING

A. Adjust floor boxes flush with finish flooring material.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Adjust boxes to be parallel with building lines. Boxes not plumb to building lines are not acceptable.

D. Install knockout closures in unused box openings.

3.04 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Nameplates and Labels
   2. Equipment Nameplates
   3. Device Labels
   4. Underground Warning Tape

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Samples of Nameplates/Labels: One of each type.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
   2. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 26, Electrical Sections. Where more than a single type is specified for application, provide single selection for each product category.

B. Equipment Nameplates:
   1. B & I Nameplates
   2. Intellicum
   3. JBR Associates
   4. Or approved equivalent.

C. Device Labels:
   1. Kroy
   2. Brady
   3. Or approved equivalent.

D. Underground Warning Tape:
   1. Allen Systems
   2. Brady

3. Or approved equivalent.

2.02 NAMEPLATES AND LABELS

A. Nameplates: Engraving stock melamine or lamicoid plastic laminate in the size and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color), punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Provide 1/8-inch thick material.
   1. Letter Color: White.
   2. Letter Height: 1/4 inch.
   3. Background Color: Black.
   4. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
   5. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or devices/equipment. Include center hole to allow attachment.
   6. Locations:
      a. Each electrical distribution and control equipment enclosure.
      b. Communication cabinets.
      c. Transformers.
      d. Disconnect switches and starters.

B. Labels: Adhesive tape, with 3/16-inch black letters on clear background. Use only for identification of individual wall switches and receptacles. Indicate device name, source panel, and source circuits. Panel and circuit designation written in permanent marker on the back of the plate and inside the back-box. Do not provide Dymo tape style labels.

C. Device plates to have panel and circuit designation engraved in face, and highlighted in a contrasting color, and the circuit written in permanent marker on the back of the plate and inside the back-box.

2.03 EQUIPMENT NAMEPLATES

A. Engraved phenolic plastic, 1/16-inch thick with beveled edge border matching letter color. All upper case letters in engraver standard letter style. Embossed tape or dymo style labels, or similar, are not acceptable.

B. Color:
   1. Normal (Utility): White letters on black background.
   2. Life Safety/Critical (Emergency Systems): Black letters on orange background per WAC 296-46B-700.9.
   3. Equipment Branch (Legally Required Standby Systems): Black letters on yellow background.
   4. X-Ray Branch (Optional Standby Systems): Black letters on white background.

C. Letter Size:
   1. Use 1/2-inch letters minimum for identifying major equipment and loads, including switchgear, switchboards, etc.
   2. Use 1/4-inch letters minimum for identifying panels, breakers, etc.
   3. Use 3/16-inch minimum for identifying source, voltage, current, phase, and wire configurations.

D. The Architect, Engineer, Commissioning Agent, and Owner reserve the right to make modifications to the nameplates as necessary.

E. Nameplates: Engraving stock melamine or lamicoid plastic laminate, Federal Specification L-P-387, in the size and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color), punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Provide 1/8-inch thick material.
   1. Letter Color: White.
   2. Letter Height: 1/4-inch.

3. Background Color: Black.
4. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.04 DEVICE LABELS

A. Extra strength, laminated, adhesive tape, with 3/16-inch black letters on clear background. Use only for identification of individual wall switches, receptacles, control device stations, etc. Indicate source panel and circuits. Wall switches with engraved buttons do not require labeling. Embossed tape style labels, or similar, are not acceptable.

B. Label all junction boxes to show system identification, source circuit, or raceway origin. In finished areas, utilize device label. In unfinished areas or above ceilings, use of permanent ink marker is acceptable.

C. Where labels are provided, write identical information in permanent ink marker on the backside of the cover.

2.05 UNDERGROUND WARNING TAPE

A. Description: 6-inch wide inert polyethylene plastic tape, 4-mil thick, detectable type, colored per APWA recommendations unless otherwise noted with suitable warning legend describing buried electrical lines.

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

B. Coordinate designations used on Drawings with equipment labels.

3.02 INSTALLATION

A. Install nameplates and labels parallel to equipment lines.

B. Secure nameplates to equipment front using self-tapping stainless steel screws.

C. Secure nameplates to inside surface of door on panelboard that is recessed in finished locations.

D. Identify underground raceways using underground warning tape. Install one continuous tape per underground raceway at 6- to 8-inches below finish grade. Where multiple underground raceways are buried in a common trench and exceeds 16-inch width, install multiple warning tapes not over 10-inches apart (edge to edge) over the entire group of underground raceways.

E. Identify empty conduit and boxes with intended use.

F. Provide wire markers on each conductor for power, control, signalling and communications circuits.

G. On the back of receptacle and switch finish plates and inside the back-box, legibly write with permanent ink marker, the circuit that each device is connected to.

H. On the front of receptacle and switch finish plates, provide label with the circuit that each device is connected to.

I. Verify emergency system distribution equipment nameplate colors with Architect/Owner.

J. Locations:
1. Switchgear, switchboards, sub-distribution switchboards, distribution panels, and branch panels.
2. Main breakers and distribution breakers in switchgear, switchboards, and distribution panels.
3. Equipment including, but not limited to, motor controllers, disconnects, and VFD's.
4. Low-voltage equipment enclosures including, but not limited to, fire alarm panels, access control panels, and lighting control panels.

K. Switchgear, switchboards, and panels to include name source, voltage, current phase, wire configuration and fault current rating. Transformers to include source KVA, and secondary voltage, phase, and wire configuration.

L. Provide nameplates for flush mounted branch panelboards identifying name on front door. On inside of door provide nameplate as noted above.

M. Provide a second label at branch panelboards listing the means of identification of branch circuit conductors. This identification legend to consist of the color code used for each voltage system (208Y/120V). See specification Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables, for required conductor color code for this project. Include identification of both voltage systems on each label, regardless of the voltage of the panelboard to which the label is affixed. Comply with requirements of NEC 210.5.

N. Provide engraved nameplate similar to distribution panelboards for transformers, lighting control panels, contactors, relays, time switches, etc. identifying name, service point and circuit number.

O. For flush mounted panelboards verify label location (inside or outside panelboard door) with Architect/Owner.

P. Provide typewritten branch panel schedules with protective clear transparent covers accounting for every breaker installed. Use actual room designations assigned by name or number near completion of the work, and not the designations shown on drawings.

Q. Where changes are made in existing panels, distribution boards, etc., provide new labeling and typewritten schedules to accurately reflect the changes.

R. Provide color coded boxes as follows:
   1. Fire Alarm: Red.

S. Provide labeling where switches control remote lighting or power outlets or where multiple switches are located in the same location.

T. Where switches control remote lighting or power outlets, or where switches or outlets in same location serve different purposes, such as light, power, intercom, etc. or different areas, such as corridor and outside, plates with 1/8-inch black letters indicating function of each switch or outlet. Also label function light switches where two or more are mounted in same locations.

U. Provide receptacle device plates with panel and circuit designation labeled on the face, with Dymo-type label, and with circuit written in permanent marker on back of plate and back-box. Provide switch device plates with panel and circuit designation written in permanent marker on back of plate and back-box.

END OF SECTION

SECTION 26 0573
ELECTRICAL DISTRIBUTION SYSTEM STUDIES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. General
   2. Protective Devices
   3. Arc Flash Labels
   4. Short Circuit Study
   5. Selective Coordination Study
   6. Arc Flash Hazard Analysis

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   2. IEEE 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
   3. IEEE 1584, Guide for Performing Arc Flash Calculation.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition provide:
   1. Power system studies required under this Section with submittals for electrical equipment, including overcurrent protective devices.
   2. Electrical equipment ordered prior to submittal of power system studies are not compliant with these specifications, and are subject to removal and replacement at no cost to Owner where not in compliance with Code and Contract Documents for selective coordination.
      a. Provide written verification with Stamp or Seal and signature of preparing Engineer.
   3. Provide samples of NFPA 70E compliant arc flash hazard labeling for electrical equipment.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Study Preparer Qualifications: Qualified engineer of switchgear manufacturer or approved professional engineer.
      a. Experienced in preparation of studies of similar type and magnitude.
      b. Familiar with software analysis products specified.
   2. Study Preparer Qualifications: Professional electrical engineer licensed in Project location and not employed by manufacturer of equipment to be provided.
   3. Study Preparer Qualifications: Electrical testing agency regularly engaged in short circuit and coordination studies, with at least 5 years experience in work of this type, and employing professional electrical engineer licensed in Project location to perform studies.
   4. Computer Software for Study Preparation: Use latest edition of commercially available software utilizing specified methodologies.
      a. Acceptable Software Products:
         1) EDSA Micro Corporation.

2) Operation Technology, Inc; ETAP.
3) SKM Systems Analysis, Inc; Power Tools for Windows.

5. Contractor Responsibility: Provide project-related data needed by study preparer, including equipment, wire sizes, insulation types, conduit types, actual circuit lengths and available fault currents from utility. Provide information in a timely matter to allow studies to be completed prior to release of equipment.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. Analyze specific electrical and utilization equipment (according to NEC definition), actual protective devices to be used, and actual feeder lengths to be installed.
   1. Scope of Studies: New and existing distribution wiring and equipment, from primary source to buses and branch circuit panelboards.
   2. Primary Source, for Purposes of Studies: Utility company primary protective devices.
   3. Study Methodology: Comply with requirements and recommendations of NFPA 70, IEEE 399, and IEEE 242.
   4. Report: State methodology and rationale employed in making each type of calculation; identify computer software package(s) used.

B. One-Line Diagrams: Prepare schematic drawing of electrical distribution system, with electrical equipment and wiring to be protected by protective devices; identify nodes on diagrams for reference on report that includes:
   1. Calculated fault impedance, X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at main switchboard bus and downstream devices containing protective devices.
   2. Breaker and fuse ratings.
   3. Generator kW and voltage ratings, percent impedance, X/R ratios, and wiring connections.
   4. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
   5. Identification of each bus, with voltage.
   6. Conduit materials, feeder sizes, actual lengths, and X/R ratios.

2.02 PROTECTIVE DEVICES

A. Provide protective devices of ratings and settings as required so that protective device closest to fault will open first.

B. Replace existing protective devices to achieve specified performance.

C. Analyze and determine ratings and settings of protective devices to minimize damage caused by fault and so that protective device closest to fault will open first.
   1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
   2. Motors with Solid-State Protective Modules: Select settings for best possible motor protection, taking into consideration actual installed motor torque and current and thermal characteristics.
   3. Identify any equipment that is underrated as specified.
   4. Identify specified protective devices that will not achieve required protection or coordination but with minor changes can be made to do so; provide such modified devices at no additional cost to Owner and identify them on submittals as "revised in accordance with Protective Device Coordination Study"; minor changes include different trip sizes in same frame, time curve characteristics of induction relays, CT ranges, etc.

5. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve change to contract sum.
6. In all cases where adequate protection or coordination cannot be achieved at no extra cost to Owner, provide a discussion of alternatives and logical compromises for best achievable coordination.
7. Do not order, furnish, or install protective devices that do not meet performance requirements unless specifically approved by Engineer.

D. Protective Device Rating and Setting Chart: Summarize in tabular format required characteristics for each protective device based on analysis; include:
1. Device identification.
2. Relay CT ratios, tap, time dial, and instantaneous pickup.
3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
4. Fuse rating and type.
5. Ground fault pickup and time delay.
6. Input level and expected response time at two test points that are compatible with commonly available test equipment and ratings of protective device.
7. Highlight devices that as furnished by Contractor will not achieve required protection.

E. Specified equipment has been designed and selected to achieve specified performance; ensure that equipment actually installed provides that performance.

F. In addition to requirements specified elsewhere, provide overcurrent protective devices having ratings and settings in accordance with results of system studies.

2.03 ARC FLASH LABELS

A. Provide label compliant with NFPA 70E guidelines indicating personal protective equipment (PPE) recommended for servicing of electrical equipment while energized, as well as calculated incident energy levels and arc flash protective boundary distance.

2.04 SHORT CIRCUIT STUDY

A. Calculate fault impedance to determine available 3-phase short circuit and ground fault currents at each bus and piece of equipment during normal conditions, alternate operations, emergency power conditions, and other operations that could result in maximum fault conditions.
1. Show fault currents available at key points in system down to fault current of 1,000 A at 208 V.
2. Include motor contributions in determining momentary and interrupting ratings of protective devices.
3. Primary Fault Level Assumptions: Obtain data from utility company.

2.05 SELECTIVE COORDINATION STUDY

A. Perform an organized normal time-current analysis of each protective device in series from individual device back to source, under emergency power conditions.
1. Graphically illustrate that adequate time separation exists between series devices, including upstream primary device.
2. Plot specific time-current characteristics of each protective device on log-log paper.
3. Organize plots so that upstream devices are clearly depicted on one sheet.
4. Also show following on curve plot sheets:
a. Device identification.
b. Voltage and current transformer ratios for curves.
c. 3-phase and 1-phase ANSI damage curves for each transformer.
d. No-damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum short circuit cutoff point.
h. Simple one-line diagram for portion of system that each curve plot illustrates.

i. Software report for each curve plot, labeled for identification.

B. Devices to coordinate down to 0.01 seconds. Coordination required for emergency systems legally required systems and elevators.

2.06 ARC FLASH HAZARD ANALYSIS

A. Calculate arc flash incident energy (AFIE) levels and flash protection boundary distances to determine required level of personal protective equipment (PPE) at each bus and piece of equipment during normal conditions, emergency power conditions, and other operations that could result in maximum arc flash incident energy levels.
   1. Show flash protection boundary distance.
   2. Include incident energy levels.
   3. List required level of protective equipment.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Provide services of qualified field engineer and necessary tools and equipment to test, calibrate, and adjust installed protective devices to conform to requirements determined by coordination analysis.

B. Adjust installed protective devices having adjustable settings to conform to requirements determined by coordination analysis.

C. Adjust solid-state protective modules for motors prior to applying load to motor.

D. Submit report showing final adjusted settings of protective devices.

3.02 ELECTRICAL POWER SYSTEM STUDIES

A. Short Circuit Analysis Study.
   1. Provide complete short circuit study, equipment interrupting and withstand evaluation. Study to include complete electrical distribution system, including simultaneous contributions from normal and alternative sources of power. Include complete low voltage distribution systems as specified in this Section.
   2. Study Basis: thoroughly cover normal and alternative operation modes that can produce maximum fault conditions, including simultaneous motor contributions.
   3. Perform study in accordance with applicable ANSI/IEEE Standards.
   4. Study Input Data: Utility company short circuit single and three phase contribution, and X/R ratio; resistance and reactance components of each feeder, busway and branch impedance; motor and generator contributions; applicable circuit parameters and contribute to short circuit duty.
   5. Calculate short circuit momentary duties and interrupting duties on basis of maximum available fault current at each switchgear bus, switchboard, motor control center, panelboards, transfer switches, busway plug connection point, dry-type transformer primary and secondary locations, other significant locations throughout system affected by available fault current (including large HVAC units, uninterruptible power supplies, etc.).
   6. Perform equipment evaluation study to determine adequacy of overcurrent protection devices by tabulating and comparing short circuit ratings of these devices with available fault current. Notify Owner in writing where problem areas or inadequacies appear in electrical equipment.
   7. Study Report: In bound final report, include sheets listing tabulated information from study, including feeder impedances, motor, utility and generator impedances and fault contributions, and resulting short circuit current including asymmetrical, symmetrical, three, five and eight cycle fault current levels, and line-to-neutral and three-phase-bolted-fault current levels at each calculated point in electrical distribution system.

B. Selective Coordination Study:
   1. Perform time-current coordination analysis with aid of computer software intended for this purpose. Include determination of settings, ratings, or types for overcurrent protective devices supplied.

2. Where necessary, make an appropriate compromise between system protection and service continuity with service continuity considered more important than system protection.
3. Provide sufficient number of computer generated log-log plots to indicate degree of system protection and coordination by displaying time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
4. Computer printouts accompany log-log plots and will contain descriptions for each of devices shown, settings of adjustable devices, short-circuit current availability at device location when known, and device identification numbers to aid in locating devices on log-log plots and system one-line diagram.
5. Study includes separate, tabular computer printout containing suggested device settings of adjustable overcurrent protective devices, equipment where device is located, and device number corresponding to device on system one-line diagram.
6. Provide computer generated system one-line diagram which clearly identifies individual equipment buses, bus numbers, device identification numbers and maximum available short-circuit current at each bus when known.
7. Discussion Section which evaluates degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
8. Call significant deficiencies in protection and/or coordination to attention of Engineer and recommendations made for improvements as soon as they are identified.
9. Contractor responsible for supplying pertinent electrical system conductor, circuit breaker, generator, and other component and system information in timely manner to allow time-current analysis to be completed prior to final installation.

C. Arc Flash Hazard Analysis:
1. Perform arc flash hazard analysis with aid of computer software intended for this purpose.
2. Perform arc flash hazard analysis in conjunction with short-circuit analysis and time-current coordination analysis.
3. Submit results of Analysis in tabular form, and include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
4. Perform analysis under worst-case arc flash conditions, and final report describes, when applicable, how these conditions differ from worst-case bolted fault conditions.
5. Arc flash hazard analysis includes recommendations for reducing AFIE levels and enhancing worker safety.
6. Proposed vendor demonstrates experience with arc Flash hazard analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in past year.
7. Proposed vendor demonstrates capabilities in providing equipment, services, and training to reduce arc flash exposure and train workers in accordance with NFPA 70E and other applicable standards.
8. Proposed vendor demonstrates experience in providing equipment labels in compliance with NEC and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

END OF SECTION

SECTION 26 0900
CONTACTORS AND CONTROL DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Contactors
   2. Photoelectric Switches
   3. Emergency Lighting Relays

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. UL 924: Standard for Safety of Emergency Lighting and Power Equipment.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Shop Drawings: Submit to NEMA ICS 1 indicating control panel layouts, wiring connections and diagrams, dimensions, support points.
   2. Product Data: Provide for each component showing electrical characteristics and connection requirements.
   3. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.06 WARRANTY

A. Warranty of materials and workmanship as outlined in Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Contactors:
   1. Asco
   2. Eaton Electrical
   3. General Electric
   4. Square D
   5. Or approved equivalent.

B. Photoelectric Switches:
   1. Precision
   2. Paragon
   3. Tork
   4. Or approved equivalent.

C. Emergency Lighting Relay:
   1. Nine 24
   2. Bodine

3. Wattstopper
4. Or approved equivalent.

2.02 CONTACTORS

A. Lighting:
   1. Continuously rated 20 amp per pole for types of ballast and tungsten lighting and resistance loads, do not derate for use on high-inrush loads.
   2. Power Contacts:
      a. Double break, silver cadmium oxide.
      b. Auxiliary arcing contacts not acceptable.
      c. Convertible Contacts, N.O. or N.C.
      d. Contact status, N.O. or N.C., clearly visible.
   3. Approved per UL 508.
   4. Design in accordance with NEMA ICS2-211B, rated for application to 600 volt maximum.
   5. Electrically Held Contactor Coil: Continuously rated and encapsulated.
   6. Mechanically Held Contactor: Encapsulated latch and unlatch coils, coil clearing contacts.

B. Power Contactors:
   1. Continuously rated 30 to 800 amp per pole for types of ballast and tungsten lighting, resistance and motor loads.
   2. Power Contacts:
      a. Totally enclosed contacts.
      b. Double break, silver cadmium oxide.
      c. Auxiliary arcing contacts not acceptable.
      d. Provide for contact inspection or replacement without disturbing line or load wiring.
   3. Straight through wiring, terminals clearly marked.
   4. Approved per UL 508.
   5. Design in accordance with NEMA ICS2-211B, rated for application to 600 volt maximum.
   6. Field Addition Accessories:
      a. Auxiliary contacts, 6 amp, 600 volt, N.O. or N.C. Maximum of four.
      b. Control circuit fuse holder, one or two fuses.
      c. Transient-suppression module for control circuit of 120 volt.
   7. Electrically Held Contactor Coil: Continuously rated and encapsulated.
   8. Mechanically Held Contactor: Encapsulated latch and unlatch coils, coil clearing contacts.

C. Enclosures: NEMA enclosure suitable for location and use, flush or surface mount as indicated on Drawings.

2.03 PHOTOELECTRIC SWITCHES

A. Characteristics:
   1. Hermetically sealed light sensitive element installed in die cast weatherproof enclosure.
   2. Adjustable external light level slide.
   3. Swivel adjustable enclosure.

B. Electrical Rating: 120VAC, 1800VA, connected for pilot duty unless otherwise indicated.

2.04 EMERGENCY LIGHTING RELAY

A. UL924 listed for connected load of 10 amps at 277 volt or 120 volt.

B. UL rated N.C. contacts, minimum 10 amps rating.

C. Integral surge protection.

D. Two separate status emergency lighting indicators for troubleshooting:
   1. Amber LED indicates presence of normal utility power.
   2. Red LED indicates presence of unswitched emergency power.

E. Manual and/or automatic diagnostic testing feature.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Contactors:
   1. Provide vibration isolation mounting pads for electrically held contactors installed within or on walls which are common to occupied spaces. Isolate terminals and operating mechanisms from enclosure.
   2. Install contactors and relays to reduce noise such that it will not create a disturbance or distraction in the areas in which such equipment is located.

B. Control Devices:
   1. Install time switches and other automatic control devices in accessible locations near the source of power or grouped at a common location in mechanical rooms or similar spaces.
   2. Install photoelectric control devices at such locations as necessary to be most effective. Avoid locating photoelectric devices in or at locations where they can be influenced by other than natural light or under eaves. Verify location of equipment with Architect.
   3. Exterior Lighting Control: Control exterior lighting and interior atrium lighting using photoelectric switches to energize contactors controlling lighting circuits. Time clocks used to deenergize lighting at any preset time if desired.
   4. Emergency Relay (UL924):
      a. Provide unswitched emergency circuit, and unswitched and switched normal circuit to UL924 relay for control of emergency luminaires with remaining room luminaires on normal power.
      b. Install each relay within dedicated 4-11/16-inch junction box with double-gang plaster ring for wall or ceiling flush-mount as indicated on Drawings. Where location in ceiling would interfere with removal of ceiling tiles, install relay flush-mounted in nearest wall at ceiling level. Do not locate behind wall switch.

3.02 TESTING

A. Test to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved drawings and specifications.
   1. Daylight sensing automatic lighting controls.
   2. Occupant sensing automatic lighting controls.
   3. Automatic time switches for lighting control.
   4. Emergency lighting controls.

B. Functionally test all control devices to ensure operation in accordance with approved drawings and specifications.

C. Prepare and complete report of test procedures and results and file with the Owner.

END OF SECTION

SECTION 26 0920
LIGHTING RELAY CONTROL PANEL

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Materials and Components
   2. Hardware Features

B. Extent of lighting control system work is indicated by drawings, and by the requirements of this Section. It is defined to include lighting relay control panels, switch inputs, energy management system for HVAC and wiring.

C. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring.

D. Basis-of-Design: Relay panel layout on Drawings are designed based on the Greengate product line. Approved manufacturers listed are allowed on condition of meeting the specified conditions including connectivity with building control systems (fire alarm, security, BAS), fail-safe operation of emergency lighting in compliance with UL 924, and separation of normal and life safety circuits. Provide additional relay enclosures and communications accessories as needed to provide the same level of functionality as shown on Drawings and required in specifications. Remove and replace electrical equipment not meeting these conditions at no cost to Owner.

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product Data: Submit manufacturer's data on lighting control system and components, including recommended spare parts list.
   2. Shop Drawings: Submit drawings of lighting control panel and accessories including, but not necessarily limited to the riser diagram / system diagram, low voltage relay panels, power and communications wiring and termination, input/output schedules and sequence of operation for each control zone.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Test the control panels and list under the UL 916 Energy Management Equipment standards.
   2. National Electrical Code (NEC) Compliance.
   3. Comply with applicable NEC requirements regarding electrical wiring standards.
   4. NEMA Compliance: Comply with applicable portions of the NEMA standards regarding the types of electrical equipment enclosures.
   5. Component Pretesting: Control equipment to undergo strict inspection standards. Previously test the equipment and burn-in at the factory prior to installation.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Provide a 3-year warranty on hardware and software. Systems that provide special warranties based on installation are not acceptable.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Greengate Lighting Control Panels Litekeeper 8

B. WattStopper

C. Intelligent Lighting Controls

D. Lighting Control and Design

2.02 MATERIALS AND COMPONENTS

A. System Description:
   1. The lighting control system consists of low voltage relay control panels with 64 programmable switch inputs and up to 8 relays.
   2. Each low voltage lighting control panel is microprocessor controlled. Accomplish programming through either the RS-232 port or through the network connection or with an integral 2 x 16 - 32 character self-prompting LCD display and programming keypad.
   3. Programmable intelligence includes time-of-day control, 32 holiday dates, a Warn Off to warn occupants of an impending off, timed inputs, preset control, auto daylight savings, astronomical clock w/offsets, and local control, digital switches and network overrides.
   4. When control panel provides a Warn Off (flash the lights) to inform the occupants of an impending off command, the Warn Off command will allow 10 extra minutes for the occupants to override their lights or exit the premises.
   5. Control panels permits lighting to be overridden ON for after-hours use or cleaning. Provide these overrides with hard-wired inputs or voice-guided touch-tone telephone control.
   6. Control panel enclosures offer a maximum space of 8 relays.
   7. N-light panel for gym lighting control.

B. Basis of Design: Lighting relay panels on Drawings are designed based on Greengate Lighting Control Panels Litekeeper product line. Approved manufacturers listed below are allowed on condition of meeting the specified conditions including the available space for the equipment (including Code required working clearances). Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.03 HARDWARE FEATURES

A. Diagnostic Aids:
   1. Each control panel to incorporate diagnostic aids for confirmation of proper operation, or in case of failure these aids to guide the individual in rapid troubleshooting of the system.
   2. The control panels to employ both a backlit LCD and LED's to indicate:
      a. POWER (LED)
      b. SYSTEM OK (LED)
      c. ON/OFF STATUS of EACH RELAY (LED & LCD)
      d. SYSTEM CLOCK AND DATE (LCD)
      e. PROGRAMMING CONFIRMATION (LCD)
   3. Control systems that do not provide visual self-help diagnostics are not acceptable.

B. Status Indication of Relays: System will provide visible status indication of relays through the window of each control panel. Visual indication to disclose ON/OFF status and relay number. Systems that do not provide relay status while the enclosure door is closed are not acceptable.

C. Operator Interface: The control panel programming interface resides in firmware in the control panel. The programming interface to consist of a circuit board mounted keypad and 2 line x 16 character LCD display. The integral keypad to provide access to the main programming features. Keypad to permit user to manually command any or all relays individually. Keypad to also allow user to link switch inputs and time schedules to relay outputs. Each panel to control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks is not permitted. Systems that utilize blocking diode technology for relay assignments are not acceptable.

D. Overrides: Controller to provide timers for each override. Provide each override timer capable of 0-999 minutes. Software to enable or disable overrides based on Priorities, Masks or Time of Day scheduling.

E. Digital Switch: Lighting controller to support digitally addressable LED annunciated switches. Maximum total number of digital switches that may exist on the lighting control network is 16,320. Each Subnet to support 64 buttons. The digital switch network requires CAT 5 cable between switches. Digital switches to control any relay group combination on the Greengate Lighting Control Panels network. Provide data communications status feedback for system checkout and troubleshooting (transmit and receive LED'S) visible on the interface.
   1. Digital switch configuration system to permit custom labeling for multiple button switch locations. Provide Decora® form and function Digital switch configuration.

F. Dry Contact Inputs: Control system to permit 8 dry contact inputs for override purposes. Support momentary 3 wire or 2 wire (toggle) inputs. Support maintained contacts as 2 wire (SPST) inputs. Provide dry contact Inputs (24VDC at 12 ma. internally supplied to the inputs). 24VDC power supply is provided with an auto-resettable fuse. Should an inappropriate electrical connection be made, design to protect the board and switches until the fault is removed. Software link switch input to any number of relays for override control. Control panel to have dry contact inputs on the logic board. Control systems that utilize separate accessories to allow for dry contact switches are not acceptable. Control systems that do not supply both digital switches and analog switches from the same controller are not permitted.

G. Photocell Control: Controller to accept dry contact ambient light sensors. Controller to provide power for the sensor thereby eliminating any external power supply. Sensors to provide for outdoor and indoor applications and issue a command to the controller once the threshold is reached. Sensor to provide user adjustable dead band control.

H. Remote Overrides: Controller to accept remote commands issued from other inputs. Controller to provide this feature without the need to add extra equipment to the controller. Remote overrides can be issued from the Telephone Interface Module (TIM), Photocells, Motion Sensors, Digital or Dry Contact Switches. Lighting systems that need to add extra equipment to receive remote overrides are not acceptable.

I. Service Override and Priority Override: Control panel to provide a three position master-service override for the control unit. Provide service override that is not accessible from the exterior. Systems that provide a service override on the exterior of the controller are not acceptable.

J. Modular Design:
   1. Control system to employ modular connectors to avoid repeat wiring in case of component failure. Mount the system CPU board on quick-release spring pins that permit an entire change out of the processor and input board.
   2. Connections for the switch inputs to incorporate modular connectors. Provide modular relay board designed for rapid field replacement or upgrading. Systems that do not employ modular connectors are not acceptable.

K. Battery Back-up: The system to utilize a memory back-up device that is system integrated and non-serviceable. Protect the data in RAM against power interruptions lasting as long as 10 years. Provide maintenance free power interrupt protection circuit.

L. Multi-tapped Transformer: The control panel incorporates the use of a multi-tapped transformer. No specification of voltage for each control location is required by panel. The voltages of 120 and 277VAC available with each standard control panel.

M. Status Indication of Relays: System to provide visible status indication of relays through the window of each control panel. Visual indication to disclose ON/OFF status and relay number.

N. Service Override: Control panel to provide a 3 position service override for the entire panel. Provide service override that is not accessible from the exterior.

O. Lockable Enclosure: Enclose each control panel in a lockable NEMA Class 1 enclosure and provide pre-punched knockouts.

P. Relays: Electrically held 20amp 120/277VAC relays. Relays must be specified Normally Open or Normally Closed. Rate the relays for 10 million mechanical operations.
   1. Standard Relay Card (SRM-NO): System to utilize normally open control relays, which are rated to 20 amps at 120/277VAC. Magnetically hold the relays and provide on a card of eight relays per card. Provide wire terminations able to accept 10 AWG. Rate the relays for 10 million mechanical operations. Provide a limited 10-year warranty on the individual relay cards. Systems that do not offer a limited 10-year warranty on installations are not acceptable.
   2. Standard Relay Module (SRM-NC): System to utilize normally closed control relays, which are rated to 20 amps at 120/277VAC. Magnetically hold the relays and provide on a card of eight relays per card. Provide wire terminations able to accept 10 AWG. Rate the relays for 10 million mechanical operations. Provide a limited 10-year warranty on the individual relay cards. Systems that do not offer a limited 10-year warranty on installations are not acceptable.
   3. Two Pole Relay Card (TPRC): Controller to provide an option for two pole relay control. The Two Pole Relay Card TPRC to offer the feature of controlling two pole voltages such as 208, 240 lighting loads at 20 amps. Provide relays that are modular in design and offer manual hand override control. Optional relay card to also provide a visual indication of relay status. The 208, 240VAC version to provide 8 relays per card. Permit combinations of relays since relays to snap into location.
   4. Latching Relay Card (LRC): Controller to provide an option to provide latching relays that are rated to 20 amps at 347VAC. Relay to provide an integral switch for both manual hand operation and visual indication of relay status. Rate the relays for 10 million mechanical operations. Provide wire terminations able to accept 6 AWG wire. Provide a limited 10-year warranty on the individual relays. Systems that do not offer a limited 10-year warranty on installations are not acceptable.
   5. High Voltage Barriers: Controller to provide as an option the ability to provide a barrier for either voltage separation or emergency circuit separation. Paint the barrier red to denote the difference.
   6. Latching Relay Card (LRC-RR7): Controller to provide an option for remote placement of the control relays. A modular card to connect into the relay compartment. Twisted (3) conductor cable to power and control the remote mounted relays. Maximum distance is 500-feet employing 18 AWG conductor.
   7. RS-232 port: Controller to provide an RJ-12 connection for RS-232 communications. Permit programming through either a local connection or remotely through a modem. The Keeper Enterprise software accessory includes a six wire communication cable to connect to the controller. Systems that do not include an on-board RS-232 port for communications are not acceptable.
   8. Monitoring / Control Software: The PC based interface software accessory provides access to lighting control system files within a Microsoft® Windows® environment. Provide software to support Windows® 2000, Windows® XP and above. The software package allows individual panel programming to be executed locally, via direct connection or remotely through a TCP/IP connection or modem. The central programming software permits the user to modify the control panel programming or configuration in an “OFF-LINE” mode. This software package stores programmed data and archives for future use. Systems using third party software are not acceptable. Systems that are not capable of creating program backups are not acceptable.
      a. Provide the following features standard in the PC based software:
         1) Standard Software Features:

2) Real Time Relay Status Monitoring
3) Alpha-Numeric Descriptors
4) Communications: Direct, TCP/IP and Modem
5) Status Indication
6) Global Software Modifications
7) Manual Relay Commands
8) Relay Pattern Commands
9) Preset Options
10) User Management - Password protection and privilege modification for multi-user security.
11) Logging of Controller Actions (switch inputs, TIM commands and relay actuations)

b. File Maintenance
1) Archive Programs
2) Data Base Restoration
3) Uploading and Downloading of Programs
4) Snap Shots - indication of changes and flawless panel restoration.

c. Software package to permit the PC to be utilized for other functions (i.e. word processing, database, etc.) besides lighting control. Systems that require an “on-line” dedicated computer for control system operation are not acceptable.

9. Stand Alone Hardware Accessories:
a. Ethernet Interface Module (EIM): Internet Connection Specifications: The control system accessory provides access to control panels over a TCP/IP connection by converting sent information into RS-232 communication capable information. This unit operates on standard 110VAC. Manufacturer to provide proper cabling from controller to Ethernet Interface Modules. RJ-45 connections are the responsibilities of others.

PART 3 - EXECUTION

3.01 INSTALLATION AND DOCUMENTATION

A. Installation: Install the control system and fully wire as shown on the drawings by the installing contractor. Complete electrical connections to control circuits, and override wiring.

B. Documentation: Provide accurate record drawings to the Owner for correct programming and proper maintenance of the control system. Record Drawings to indicate the load controlled by each relay and the relay panel number.

C. Operation and Maintenance Manuals: Provide factory operation and maintenance manuals.

3.02 PRODUCT SUPPORT AND SERVICE

A. Factory Support: Provide factory telephone support available at no cost to the Owner. Factory assistance to consist of solving programming or application questions concerning the control equipment.

3.03 SYSTEM ACCEPTANCE

A. Test to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved drawings and specifications.

B. Functionally test sequences of operation to ensure operation in accordance with approved drawings and specifications.

C. Prepare and complete report of test procedures and results and file with the Owner.

D. An operational user program to exist in the control system. Program to execute and perform functions required to effectively operate the site according to the requirements.

E. Demonstration of program integrity during normal operation and pursuant to a power outage.

F. Provide a minimum of 2 hours training on the operation and use of the control system.

G. Lighting System Control Testing and Commissioning:

1. Test lighting controls to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with Drawings and Specifications. Provide functional testing of sequences of operation to ensure operation in accordance with Drawings and Specifications. Provide complete report of test procedures and results to engineer and insert approved copy into project closeout documents.
2. Testing to Include:
   a. Daylight Automatic Controls
   b. Occupant Sensing Automatic Controls
   c. Automatic Time and Override Controls for Interior Lighting
   d. Automatic Time and Photo Controls for Exterior Lighting

END OF SECTION

SECTION 26 0923
OCCUPANCY/VACANCY SENSORS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Occupancy/Vacancy Sensors (Ceiling and Wall mounted)
   2. Combined Occupancy Sensor/Wall Switches ("Sensor/Switches")

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Provide wiring diagrams indicating low voltage and line voltage wiring requirements.
   2. Provide, on reproducible architectural floor plan, a layout of sensors indicating their sensing distribution.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Use manufacturer's published testing and adjusting procedures to adjust sensors time delay, daylight sensitivity, and passive infrared sensitivity to satisfaction of the Owner.
   2. Prepare and complete report of test procedures and results. Submit these test procedures and results to Owner and Engineer and Architect.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Passive Infrared Occupancy/Vacancy Sensors:
   1. Sensor Switch
   2. WattStopper
   3. Hubbell
   4. Greengate

B. Ultrasonic Occupancy/Vacancy Sensors:
   1. WattStopper
   2. Hubbell
   3. Greengate
   4. Sensor Switch

C. Dual Technology Occupancy/Vacancy Sensors:
   1. WattStopper
   2. Hubbell
   3. Greengate
   4. Sensor Switch

D. Combined Occupancy/Vacancy Sensor/Wall Switch:
   1. Sensor Switch
   2. WattStopper
   3. Hubbell
   4. Greengate

E. Basis of Design: Occupancy/Vacancy sensor layout on Drawings are designed based on WattStopper product line. Approved manufacturers listed are allowed on condition of meeting the specified conditions including complete sensor coverage of the area controlled and switching of luminaires in the area controlled. Provide additional sensors and power switch packs as needed to provide the same level of functionality as shown on Drawings or required in Specifications. Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.02 GENERAL

A. Occupancy sensor designation indicates sensors automatically turn lights ON when the sensor detects the presence of a person and will automatically turn lights OFF when no presence is detected for a specified amount of time (automatic-on and automatic-off).

B. Vacancy sensor designation requires someone to manually turn the lights ON. The sensor will then automatically turn the lights OFF when no presence is detected for a specified amount of time (manual-on and automatic-off).

C. Provide occupancy sensors to sense presence of human activity within desired space and enable or disable on/off manual lighting control function provided by local switches.

D. Upon detection of human activity by detector, sensor initiates time delay to maintain lights on for present period of time. Field adjustable time delay setting from 30 seconds to 15 minutes.

E. Factory set sensors for maximum sensitivity.

F. LED lamp built into sensor indicates when occupant is detected.

G. Provide zero cross relay control with sensors and sensor/switched; relay contacts close and open with AC voltage signal is at zero.

H. Where line voltage sensors and sensor/switches are used, provide to match voltage of controlled circuit.

I. Line Voltage Sensors, Control Units, and Relays: UL listed.

2.03 OCCUPANCY/VACANCY SENSORS (CEILING AND WALL MOUNTED)

A. Passive Infrared Sensors:
   1. Sensor Function: Detects human presence in floor area being controlled by detecting changes in Infrared energy. Sensor detects small movements, i.e., when people are writing while seated at a desk.
   2. Provide temperature compensated dual element pyro-electric sensor and with multi element Fresnel lens.
   3. Sensor utilizes DIP switches for adjustment to time delay and override. Field adjustable settings for sensitivity.
   4. Provide daylight filter to ensure that sensor is insensitive to short-wavelength infrared waves, i.e., those emitted by sun.
   5. Adjustments and mounting hardware under removable cover to prevent tampering with adjustments and hardware.
   6. Sensor utilizes advanced digital signal processing technology to reduce false offs without reducing sensitivity.
   7. Ceiling-Mounted Sensor:
      a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
      b. 360 degree sensor range; coverage: 1200 SF, unless otherwise noted on drawings.
      c. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.

d. Provide internal form C dry contacts for HVAC control.
e. Basis of Design: Wattstopper CI-300 Series

8. Wall-Mounted Sensor:
   a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
   b. 90 degree sensor range with dense wide angle lens; coverage: 1000 SF for desktop motion, unless otherwise noted on Drawings.
   c. Swivel mounting bracket for corner mounting to wall or ceiling.
   d. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
   e. Provide internal form C dry contacts for HVAC control.
   f. Basis of Design: Wattstopper CX Series

B. Ultrasonic Occupancy/Vacancy Sensors:
   1. Sensor Function: Detects human presence in controlled floor area by detecting Doppler shifts in 40kHz ultrasound created by sensor.
   2. Sensors are precision crystal controlled and do not interfere with each other when two or more are placed in same area. Sensor includes advanced digital signal processing to reduce false on signals without decreasing sensitivity, as well as immunity to RFI/EMI sources.
   3. Sensor utilizes DIP switches for adjustment to time delay and override. Field adjustable settings for sensitivity.
   4. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
   5. Provide adjustments and mounting hardware under removable cover to prevent tampering.
   6. Ceiling-Mounted Sensor:
      a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
      b. Maximum protrusion of 1.1-inches and blend in aesthetically with ceiling.
      c. Coverage: 360 degree sensor range; coverage: 2,000 SF, unless otherwise noted on Drawings.
      d. Provide internal form C dry contacts for HVAC control.
      e. Basis of Design: Wattstopper WT Series
   7. Ceiling Mounted Sensor - Hallway Sensor Coverage:
      a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
      b. Maximum protrusion of 1.5-inches and blend in aesthetically with ceiling.
      c. Coverage: 90 lineal feet.
      d. Provide internal form C dry contacts for HVAC control.
      e. Basis of Design: Wattstopper UT-300-3 Series

C. Dual Technology Sensors:
   1. Sensor Function: Combined capability of passive infrared with ultrasonic or microphonic technology as described above.
   2. Function: Upon a person entering a space, motion must be sensed by both technologies before lighting will be turned on. After this has occurred, detection by either technology will hold lighting on. Sensors retrigger time delay where only one motion is necessary to turn on lights within 5 seconds after turning off.
   3. Wall-Mounted Sensor:
      a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
      b. 90 degree sensor range with dense wide angle lens, coverage; 1000 SF for desktop motion, unless noted on drawings.
      c. Swivel mounting bracket for corner mounting to wall or ceiling.
      d. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.

e. Provide internal form C dry contacts for HVAC control.
f. Basis of Design: Wattstopper DT Series

4. Ceiling-Mounted Sensor:
   a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
   b. 360 degree sensor range; coverage: 1000 SF for half-step motion, unless otherwise noted on Drawings.
   c. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
   d. Provide internal form C dry contacts for HVAC control.
   e. Basis of Design: Wattstopper DT-300 Series

2.04 COMBINED OCCUPANCY/VACANCY SENSOR/WALL SWITCHES ("SENSOR/SWITCHES")

A. Completely self-contained sensor system that fits into standard single gang box. Internal transformer power supply, latching dry contact relay switching mechanism compatible with electronic ballasts, compact fluorescent, and inductive loads. Triac and other harmonic generating devices are not allowed.

B. Passive infrared sensor technology includes advanced signal processing to reduce false triggers without increasing sensitivity. LED indicator blinks when occupant sensed.

C. Rated to switch loads: 800 watts incandescent or 120-volt ballast; 1000 watts 277 volt ballast. Zero-crossing technology switches lighting off when AC voltage is at zero, minimizes contact wear.

D. Provide adjustable daylight feature that holds lighting "off" when desired footcandle level is present.

E. Provide integral off override switch with no leakage current to load or ground.

F. Vandal-resistant lens.

G. Includes neutral wire to meet NEC 2014 Code.

H. Finish: White.

I. Alerts for impending shut-off: light flash, audible, both or none.

J. Standard Sensor/Switch:
   1. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off). Factory set to manual on/auto off.
   2. 180 degree sensor range; coverage: 150 SF for desktop activity.
   3. Basis of Design: Wattstopper PW-101 Series

K. Dual Relay Sensor/Switch:
   1. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
   2. Dual auto-off buttons on face of switch allow end-user to turn off two switch legs in room space. Built-in light adjustable level sensor only turns off second of two relays when desired footcandle level is present. Otherwise similar to specifications above for single-zone sensor/switch.
   3. Defaults to Manual-ON to 50% operation for maximum energy savings.
   4. 180 degree sensor range; coverage: 150 SF for desktop activity.
   5. Finish: White.
   6. Basis of Design: Wattstopper PW-302

L. Sensor/Slide Dimmer:
   1. Line voltage slider dimmer allows for manual adjustment of lighting levels from 100 percent to 10 percent; compatible with two-wire line voltage 100 percent to 10 percent electronic dimming ballasts. Separate manual button for override 'off' control.
   2. 180 degree sensor range; coverage: 300 SF for desktop activity.
   3. Basis of Design: Wattstopper PW-100D/101D Series

M. Passive Infrared Wall Switch Vacancy-Only Sensors:

1. Operates only as a vacancy sensor (manual-on and automatic-off).
2. Adjustable sensitivity (high, low presets).
3. Basis of Design: Lutron Maestro MS Series.

N. Dual Technology Wall Switch Vacancy-Only Sensors:
1. Operates only as a vacancy sensor (manual-on and automatic-off).
2. Adjustable sensitivity (high, medium, low, and off presets) individually for passive infrared and ultrasonic sensing.
3. Basis of Design: Lutron Maestro MS Series.

O. Passive Infrared Wall Dimmer Vacancy-Only Sensors:
1. Operates only as a vacancy sensor (manual-on and automatic-off).
2. If more than one model is required, the optional choice can be used to assign type designations. Make sure that designations indicated on the drawings are consistent with those specified here.
3. Basis of Design: Lutron Maestro MSCL Series.

P. Passive Infrared 0-10 V Wall Dimmer Vacancy-Only Sensors:
1. Operates only as a vacancy sensor (manual-on and automatic-off).
2. If more than one model is required, the optional choice can be used to assign type designations. Make sure that designations indicated on the drawings are consistent with those specified here.
3. Basis of Design: Lutron Maestro 0-10V Dimmer Sensor MS Series.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install occupancy/vacancy sensors as directed by manufacturer's instructions. Complete connections to control circuits, occupancy sensors, power supply pack and low voltage wiring.

B. Provide power packs for sensor to control number of circuits and/or switch legs within its area of coverage.

C. Field adjust each sensor to maximize its coverage of room space.

D. Relocate sensors with ultrasonic technology to avoid being closer to HVAC diffusers and power packs than recommended by manufacturer.

E. Field set time delay for each device as noted below:
1. Classrooms and Conference Rooms: 30 minutes.
2. Restrooms: 15 minutes.
3. Storage Rooms, Janitor's Closets, Unisex Restrooms: 5 minutes.
4. All Other Spaces: 15 minutes.
5. Time Switches: 2-hours.

F. Prior to applying dimming controls, maintain fluorescent lighting at full output for minimum of 100 hours. If this is not done, replace lamps and ballasts of affected luminaires at no cost to Owner.

G. Parking Lot Lighting Controlled by Occupancy Sensor: Provide two occupancy sensors per pole for 360-degree coverage at each pole. Mount sensors at 10 to 15-feet above grade (minimum 5-feet below pole lighting). Provide HID bi-level controller for each luminaire, mounting controller to adjoin luminaire and securing to pole arm. Provide liquid-tight, flexible metallic conduit and raintight junction box as needed to splice wiring between occupancy sensor and HID bi-level controller per manufacturer's installation instructions, and as allowed by luminaire manufacturer. Paint exposed conduit and junction box to match pole finish.

H. Coordinate HVAC control requirements with controls contractor prior to installation.

3.02 LIGHTING SYSTEM TESTING AND COMMISSIONING

A. Test lighting controls to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with Drawings and Specifications. Provide functional testing of sequences of operation to ensure operation in accordance with Drawings

and Specifications. Provide complete report of test procedures and results to engineer and insert approved copy into project closeout documents.

B. Testing includes:
   1. Daylight Automatic Controls
   2. Occupant Sensing Automatic Controls
   3. Automatic Time and Override Controls for Interior Lighting
   4. Automatic Time and Photo Controls for Exterior Lighting

END OF SECTION

SECTION 26 0924
DAYLIGHTING CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Continuous Dimming Daylighting Controller
   2. Local Continuous Dimming Photosensor

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards per Division 01, General Requirements and Section 26 00 00, Electrical Basic Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Wiring diagrams indicating low voltage and line voltage wiring requirements.
   2. A layout of sensors indicating their sensing distribution on reproducible architectural floor plan.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Daylighting controls that carry a factory warranty for a minimum 5-year duration.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. WattStopper

B. Greengate

C. Sensor Switch

D. Basis of Design: Daylighting sensor layout on Drawings are designed based on WattStopper product line. Approved manufacturers listed below are allowed on condition of meeting specified conditions including complete sensor coverage of area controlled and switching of luminaires in area controlled. Provide additional sensors and power switch packs as needed to provide same level of functionality as shown on Drawings. Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.02 CONTINUOUS DIMMING DAYLIGHT CONTROLLER

A. Control dimming of interior lights in response to light level data, compatible with 0 to 10VDC dimming ballasts. Control system to be open loop, to provide three output control zones consisting of a 0 to 10VDC signals compatible with fluorescent dimmable ballasts. Control system to include three relay outputs capable of switching each of three output zones off after an adjustable time delay when a given channel is fully dimmed.

B. Control module to include following characteristics:
   1. Seven individually adjustable parameters for each channel:
      a. Setpoint: 5 to 60 footcandles;

b. Minimum Output: 0 to 4 volts DC;
c. Maximum Output: 6 to 10 volts DC;
d. Ramp Rate: 5 to 60 seconds;
e. Fade Rate: 5 to 60 seconds;
f. Cutoff Time Delay: 0 to 20 minutes or disabled;
g. Load Shed Limit: 0 to 10 volts DC.

2. Compatible with 0 to 10VDC dimming ballasts.
3. Suitable for panel mounting on DIN rail.
4. When daylighting is adequate for a channel to fully dim; lights switch off after an adjustable time delay via relay pack connected to controller. This feature can also be disabled if lights must remain when fully dimmed.
5. LCD display with menu-driven, pushbutton programming without special tools or accessories; automatic internal calculation for dimming requirements of individual channels for simplified setup.
6. Operates from either 120VAC or 277VAC power source.
7. Automatic Off Control.

C. Utilize low voltage photosensor to continuously measure light levels. Photosensor range is 30 to 6000 footcandles. Adjustments and calibrations capable of being made at control module, not at remote photosensor.

D. Basis of Design: WattStopper LCD-203 series control module with LS-290C photosensor and WattStopper BT-203 power pack. Control module mounted in factory-approved enclosure with factory-installed DIN rails (WattStopper LS-E8, LS-E12, or approved equivalent) and DC power supplies as needed.

2.03 LOCAL CONTINUOUS DIMMING PHOTOSENSOR

A. Provide low voltage, indoor photocell to interface with electronic dimming ballasts using low voltage (0 to 10VDC) control signal.

B. Spectral filtering system to measure relative levels of daylighting and indoor lighting within control space. Measures light as human eye perceives; linear photocell response with greater than 1 percent accuracy.

C. Ceiling-mounted 2.4-inch diameter, 0.875-inch depth white housing.

D. 10VDC input voltage, 0.2 to 10VDC output voltage. 20 to 60 footcandle adjustable range with plus or minus 3 percent accuracy. One photocell controls up to 50 ballasts. 5 year warranty. White finish.

E. Automatic Off Control.

F. Provide with separate handheld remote controller to field program target lighting levels for daytime and nighttime (i.e. when plenty of daylighting is available and when no daylighting is available).

G. Basis of Design: WattStopper LS-301 Series.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install photocells as directed by manufacturer's instructions. Complete connections to control circuits, photocells, control modules, power supply pack and low voltage wiring.

B. Photocell placement and wiring:
1. Drawings are schematic, and show photocell quantities together with the daylighting zones that they control.
2. Reference manufacturer installation instructions for the recommended location and orientation of photocell with respect to exterior glazing and both interior and exterior lighting.
3. Reposition sensor at no additional cost to Owner to avoid conflict between sensor and object obscuring its view, and between sensor and both interior and exterior lighting that

causes daylighting controls to repeatedly increase and decrease in brightness (i.e. "cycling").

4. Field wire photocell for correct footcandle range (i.e. WattStopper LS-290C photocell has three jumper selectable footcandle ranges: 3 to 300 fc, 30 to 3000 fc, 60 to 6000 fc).

C. Prior to applying continuous dimming daylighting controls, maintain fluorescent lighting at full output for minimum of 100 hours. If this is not done, replace lamps of affected luminaires at no cost to Owner.

3.02 LIGHTING SYSTEM DEMONSTRATION, TRAINING, TESTING AND COMMISSIONING

A. Prior to adjusting and calibrating daylighting control system and local photocell field adjustable settings, contact local manufacturer representative and arrange for representative to visit site to educate both field installer and Owner representative on the operation of the controls.

B. Use manufacturer's published testing and adjusting procedures to adjust sensors and daylight sensitivity to the satisfaction of Owner and in compliance with Washington State Energy Code 1513.7.

C. Prepare and complete report of test procedures and results. Submit these test procedures and results to Engineer.

D. Training: Provide minimum 2-hour training session to Owner representatives at a time approved by Owner after Owner has received approved operation and maintenance manuals. Training to include discussion of operation, adjustment, and replacement of sensors, photocells and control.

E. Test lighting controls to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with Drawings and Specifications. Provide functional testing of sequences of operation to ensure operation in accordance with Drawings and Specifications. Provide complete report of test procedures and results to engineer and insert approved copy into project closeout documents.

F. Testing Includes:
1. Daylight Automatic Controls
2. Occupant Sensing Automatic Controls
3. Automatic Time and Override Controls for Interior Lighting
4. Automatic Time and Photo Controls for Exterior Lighting

END OF SECTION

SECTION 26 0925

DIGITAL LIGHTING CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Work included: Provision of materials, installation and testing of:
   1. General Performance
   2. Digital Wall or Ceiling Mounted Occupancy Sensor System
   3. Digital Wall Switches
   4. Handheld Remote Controls
   5. Room Controllers
   6. Digital Photosensors
   7. Room Network (DLM Local Network)
   8. Configuration Tools
   9. Network Bridge
   10. Segment Manger
   11. Emergency Lighting
   12. Bus Supply
   13. Hand Held Programmer
   14. Source Quality Control

B. Basis of Design: Occupancy sensor layout on Drawings are designed based on Wattstopper DLM product line. Approved manufacturers listed below are allowed on condition of meeting specified conditions including complete sensor coverage of area controlled and switching of luminaires in area controlled. Provide additional sensors and power switch packs as needed to provide same level of functionality as shown on Drawings. Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

C. System Description and Operation:
   1. The Lighting Control and Automation system as defined under this section covers the following equipment:
      a. Digital Room Controllers: Self-configuring, digitally addressable one, two, or three relays controllers with 0-10 volt control for ballasts (if applicable) and single relay application-specific plug load controllers.
      b. Digital Occupancy Sensors: Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
      c. Digital Switches: Self-configuring, digitally addressable pushbutton switches, dimmers, and scene switches with two-way active infrared (IR) communications.
      d. Digital Photosensors: Single-zone closed loop and multi-zone open loop daylighting sensors with two-way active infrared (IR) communications can provide switching or dimming control for daylighting harvesting.
      e. Configuration Tools: Handheld remote for room configuration provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send and receive of room variables and store of occupancy sensor settings. Computer software also customizes room settings.
      f. Handheld Remotes for Personal Control: One-button dimming, two-button on/off, or five-button scene remotes provide control using infrared communications. Remote may be configured in the field to control selected loads or scenes without special tools.
      g. Digital Lighting Management (DLM) Local Network: Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.

h. Network Bridge: Provides BACnet MS/TP-compliant digital networked communication between rooms, panels, and the Segment Management or building automation system (BAS).
i. Segment Manger: Provides web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
j. Emergency Lighting Control Unit (ELCU): Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building.

D. Lighting Control Applications:
1. Unless relevant provisions of the applicable local Energy Codes are more stringent, provide a minimum application of lighting controls as follows:
a. Space Control Requirements: Provide occupancy/vacancy sensors with Manual-ON functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling-or corner-mounted sensors and Manual-ON switches.
b. Daylit areas: All luminaires within 15-feet of windows or within 7-feet of skylights (the daylit zones) will be controlled separately from luminaires outside of daylit zones. Luminaires closest to the daylight aperture will be controlled separately from luminaires farther from the daylight aperture, within the daylight zone.
c. Daytime setpoints for total ambient illumination (combined daylight and electric light) level that initiate dimming will be programmed to be not less than 125% of the nighttime maintained designed illumination levels.
d. Multiple-leveled switched daylight harvesting controls may be utilized for areas marked on Drawings.
e. Provide smooth and continuous daylight dimming for areas marked on Drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards per Division 01, General Requirements and Section 26 00 00, Electrical Basic Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
1. Layout of sensors indicating their sensing distribution on reproducible Architectural Floor Plans.
2. Shop Drawings: Provide wiring diagrams indicating low voltage and line voltage wiring requirements for occupancy sensors, and each daylighting control system shown on the electrical drawings.
3. Closeout Submittals:
a. Sustainable Design Closeout Documentation: Lighting Control System Manufacturer to provide Enhanced Start-up documentation that details the start-up procedure being performed including a process to follow, details on tests performed and an area that documents any test results.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Manufacturer: Minimum 10 years experience in manufacture of architectural lighting controls.
   2. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.
   3. Lighting Control System Components: Listed by UL specifically for the required loads. Provide evidence of compliance upon request.
   4. Prior to adjusting and calibrating daylighting control system and local photocell field adjustable settings, contact local manufacturer representative and arrange for representative to visit site to educate both field installer and Owner representative on the operation of the controls.
   5. Prior to applying continuous dimming daylighting controls, maintain fluorescent lighting at full output for minimum of 100 hours. If this is not done, replace lamps and ballasts of affected luminaires at no cost to Owner.
   6. Use manufacturer's published testing and adjusting procedures to adjust sensors time delay, daylight sensitivity, and passive infrared sensitivity to satisfaction of Owner.
   7. Training: Provide minimum 4-hour training session to Owner representatives at a time approved by Owner after Owner has received approved operation and maintenance manuals. Training to include discussion of operation, adjustment, and replacement of sensors, photocells and control.
   8. Prepare and complete report of test procedures and results. Submit these test procedures and results to Owner.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Provide manufacturer's warranty covering 5 years with Lutron startup on EcoSystem modules from date of Substantial Completion.
   2. Provide manufacturer's Enhanced 8 Year Limited Warranty for daylight sensors, occupancy sensors, wall stations, bus supply, and infrared receivers
      a. 8-year limited parts warranty for the replacement of defective lighting components from the date of Substantial Completion.
      b. 2-year Silver Level Support and Maintenance Plan that covers 100 percent parts and labor from the date of the Substantial Completion.
   3. Provide manufacturer's full 4 year warranty covering 100 percent parts and 100 percent labor from the date of Substantial Completion. Plan: includes 100 percent parts and labor coverage, 24 hours per day, 7 days per week telephone technical support, and can be renewed under separate contract.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Wattsopper DLM

B. N-Lite

C. Or approved equivalent.

2.02 GENERAL PERFORMANCE

A. Daylight Harvesting and Occupant Detection to Control Lighting with the Following Hierarchy:
   1. Emergency (Highest Priority): Ignores all other inputs.
   2. Programming: During system programming, sensor inputs are ignored.
   3. Occupant Sensor: Allows lights to be on/off.

4. Daylight Sensor: Imposes a high end limit for light output.
5. Personal Control: Fine tune light levels up to the daylight sensor limit.

B. Response to a single sensor can be unique on luminaire by luminaire basis.

C. Power failure recovery - All devices return to their previous light level prior to power loss.

D. All programmable devices with integral power failure memory to maintain settings for a minimum of 10 hours during power loss.

E. Wall station and sensor replacement accomplished without programming.

2.03 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

A. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters.

B. Digital Occupancy Sensors will provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
1. Digital calibration and pushbutton programming for the following variables:
a. Sensitivity: 0-100% in 10% increments.
b. Time delay: 1-30 minutes in 1 minute increments.
c. Test mode: Five second time delay.
d. Detection technology: PIR, Ultrasonic or Dual Technology activation and/or re-activation.
e. Walk-through mode.
f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
2. One or two RJ-45 port(s) for connection to DLM local network.
3. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
4. Device Status LEDs including:
a. PIR Detection
b. Ultrasonic detection
c. Configuration mode
d. Load binding
5. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
6. Manual override of controlled loads.

C. Units will not have any dip switches or potentiometers for field settings.

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

E. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC.

2.04 DIGITAL WALL SWITCHES

A. Low voltage momentary pushbutton switches in 1,2,3,4,5, and 8 button configuration; available in white, light almond, ivory, grey, and black; compatible with wall plates with decorator opening. Wall switches will include the following:
1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
3. Red configuration LED on each switch that blinks to indicate data transmission.
4. Blue Load/Scene Status LED on each switch button with the following characteristics:
a. Bi-level LED.
b. Dim locator level indicates power to switch.
c. Bright status level indicates that load or scene is active.

5. Dimming switches will include seven bi-level LEDs to indicate load levels using 14 steps.

B. Two RJ-45 ports for connection to DLM local network.

C. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.

D. The following switch attributes may be changed or selected using a wireless configuration tool:
   1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
   2. Individual button function may be configured to Toggle, On only, or Off only.
   3. Individual scenes may be locked to prevent unauthorized change.
   4. Fade Up and Face Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
   5. Ramp rate may be adjusted for each dimmer switch.
   6. Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.

E. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101.

2.05 HANDHELD REMOTE CONTROLS

A. Battery-operated handheld switches in 1, 2, and 5 button configuration for remote switching or dimming control. Remote controls will include the following features:
   1. Two-way infrared (IR) transceiver for line of sight communication with DLM local network within up to 30 feet.
   2. Blue LED on each button confirms button press.
   3. Load buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.
   4. Inactivity timeout to save battery life.

B. A wall mount holster and mounting hardware will be included with each remote control.

C. WattStopper part number: LMRH-101, LMRH-102, LMRH-105.

2.06 ROOM CONTROLLERS

A. Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:
   1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
   2. Simple replacement - Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
   3. Device Status LEDs to indicate:
      a. Data transmission
      b. Device has power
      c. Status for each load
      d. Configuration status
   4. Quick installation features including:
      a. Standard junction box mounting
      b. Quick low voltage connections using standard RJ-45 patch cable
   5. Plenum rated
   6. Manual override and LED indication for each load
   7. Dual voltage (120/277 VAC, 60 Hz)
   8. Zero cross circuitry for each load.

B. On/Off/Dimming enhanced Room Controllers shall include:
   1. Real time current monitoring
   2. Three relay configuration
   3. Efficient 250 mA switching power supply
   4. Four RJ-45 DLM local network ports.
   5. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
   6. Network Bridge for BACnet MS/TP communications (LMRC-3xx).
   7. The following dimming attributes may be changed or selected using a wireless configuration tool:
      a. Establish preset level for each load from 0-100%
      b. Set high and low trim for each load
      c. Set lamp burn in time for each load up to 100 hours
   8. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
      a. One relay configuration only
      b. Automatic-ON/OFF configuration
   9. WattStopper product numbers: LMRC-213.

2.07 DIGITAL PHOTOSENSORS

A. Digital photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open loop photosensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones. Photosensors shall be interchangeable without the need for rewiring.

B. Digital photosensors include the following features:
   1. An internal photodiode that measures only within the visible spectrum, and has a response curve that closely matches the photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
   2. Sensor light level range shall be from 1-10,000 footcandles (fc).
   3. The capability of switching one-third, one-half or all lighting ON and OFF, or raising or lowering lighting levels, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
   4. For switching daylight harvesting, the photosensor shall provide a deadband or a separation between the “ON Setpoint” and the “OFF Setpoint” that will prevent the lights from cycling after they turn off.
   5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a user-selectable minimum level.
   6. Programmable wall switch override to allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise and lower lighting levels for a selected period of time or cycle of occupancy.
   7. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
   8. Red configuration LED that blinks to indicate data transmission.
   9. Blue status LED indicates test mode, override mode and load binding.
   10. Recessed switch to turn controlled load(s) ON and OFF.
   11. One RJ-45 port for connection to DLM local network.
   12. An adjustable head and a mounting bracket to accommodate multiple mounting methods and building materials. The photosensor may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox.

C. Open loop digital photosensors include the following additional features:

1. An internal photodiode that measures light in a 60 degree angle cutting off the unwanted light from the interior of the room.
2. Automatically establishes setpoints following calibration using a wireless configuration tool or a PC with appropriate software.
3. A proportional control algorithm for dimming daylight harvesting with a “Setpoint” to be maintained during operation.
4. WattStopper Product Number: LMLS-500.

2.08 ROOM NETWORK (DLM LOCAL NETWORK)

A. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building. Digital room devices connect to the network using CAT 5e cables with RJ-45 connectors which provide both data and power to room devices. Features of the DLM local network include:
   1. Plug n’ Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
   2. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
   3. Push n’ Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
   4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

2.09 CONFIGURATIONS TOOLS

A. A configuration tool facilitates optional customization of DLM local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface.

B. Features and functionality of the wireless configuration tool shall include:
   1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
   2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
   3. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
   4. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
   5. Temporarily adjust light level of any load(s)on the local network, and incorporate those levels in scene setting.
   6. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.

C. WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100.

2.10 NETWORK BRIDGE

A. The network bridge connects a DLM local network to a BACnet-compliant network for communication between rooms, panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication.
   1. The network bridge may be incorporated directly into the room controller hardware (LMRC-3xx Room Controllers) or be provided as a separate module connected on the local network through an available RJ-45 port.
   2. Provide Plug n’ Go operation to automatically discover all room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.

3. The network bridge shall automatically create standard BACnet objects for selected room device parameters to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM room devices on each local network. Standard BACnet objects shall be provided as follows:
   a. Read/write the normal or after hours schedule state for the room
   b. Read the detection state of the occupancy sensor
   c. Read/write the On/Off state of loads
   d. Read/write the dimmed light level of loads
   e. Read the button states of switches
   f. Read total current in amps, and total power in watts through the room controller
   g. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
   h. Activate a preset scene for the room
   i. Read/write daylight sensor fade time and say and night setpoints
   j. Read the current light level, in footcandles, from interior and exterior photosensors and photocells
   k. Set daylight sensor operating mode
   l. Read/write wall switch lock status
4. WattStopper product numbers: LMBC-300

2.11 SEGMENT MANAGER

A. The Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser. Each segment manager shall have support for one segment networks as required and allow for control of a maximum of 127 local networks (rooms) and/or lighting control panels per segment network.

B. Operational features of the Segment Manager shall include the following:
   1. Connection to PC or LAN via standard Ethernet TCP/IP.
   2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser.
   3. Log in security capable of restricting some users to view-only or other limited operations.
   4. Automatic discovery of all DLM devices on the segment network(s). Commissioning beyond activation of the discovery function shall not be required.
   5. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
   6. Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation.
   7. Ability to set up schedules for rooms and panels. Schedules shall automatically set controlled zones or areas to either a normal hours or after hours mode of operation.
   8. Ability to group rooms and loads for common control by schedules, switches or network commands.
   9. Ability to monitor connected load current and display power consumption for areas equipped with room controllers incorporating the integral current monitoring feature.
   10. Provide seamless integration with the BAS via BACnet IP

C. WattStopper Product Numbers: LMSM-201.

2.12 EMERGENCY LIGHTING

A. Emergency Lighting Control Unit - A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
   1. 120/277 volts, 50/60 Hz., 20 amp ballast rating
   2. Push to test button
   3. Auxiliary contact for remote test or fire alarm system interface

B. WattStopper Product Numbers: ELCU-100, ELCU-200.

2.13 BUS SUPPLY

A. General:
   1. Connect Without Interface to:
      a. Occupancy sensors.
      b. Fire alarm or security system contact closures.
      c. Emergency lighting interface, UL 924 listed.
   2. Supports one or two independent links of up to 64 ballasts per link.
   3. Integral fault protection to prevent bus supply failure in the event of a mis-wire.
   4. LED status indicators:
      a. Bus supply powered.
      b. Bus supply operating properly.
      c. Bus communication.
      d. Emergency condition active / non-active.
   5. Configuration Switches:
      a. Override bus to full light output.
      b. Override bus to low end.
      c. Override bus to off.
      d. Closure inputs normally open/closed.
   6. Enable/disable system programming (lockout).
   7. Stores and automatically replaces settings of single-ballast replacements.

B. Field Mounted Bus Supply: Integral clip for mounting on DIN rail.

C. Wall Mounted Bus Supply: Provide digital bus power supply in a pre-assembled NEMA listed enclosure with terminal blocks listed for field wiring.

2.14 HAND HELD PROGRAMMER

A. General:
   1. Wireless programming for all system settings.
   2. Secured via pass code.
   3. Allow for replacement of single or multiple ballasts via serial number recognition of non-functioning ballast and a short programming menu.
   4. Only operate as a lighting control device.
   5. Non-volatile memory stores lighting control software for minimum of 10 years for power loss.
   6. Programmer stores non-system specific configuration settings. System specific configuration settings to be stored in ballasts and bus supply.

2.15 SOURCE QUALITY CONTROL

A. Perform full-function testing on all completed assemblies at end of line.

B. Diagnostics and Service - Tiered control scheme for dealing with component failure that minimizes loss of control for occupant.
   1. Bus Failure: Lights go to emergency level for safety.
   2. Failure of One Sensor Type: Ballast still controllable via other sensors.
   3. Ballast Failure: Only impacts one fixture - remainder of system operates as programmed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions.

B. Provide complete installation of system in accordance with Contract Documents.

C. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

D. Install photocells as directed by manufacturer's instructions. Complete connections to control circuits, photocells, control modules, power supply pack and low voltage wiring.

E. Verify with manufacturer's representative that sensors and photocells are laid out in compliance to manufacturers published sensing distribution. Provide additional sensors for complete coverage of space being sensed.

F. Photocell Placement and Wiring:
   1. Drawings are schematic, and show photocell quantities together with the daylighting zones that they control.
   2. Reference manufacturer installation instructions for the recommended location and orientation of photocell with respect to exterior glazing and both interior and exterior lighting.
   3. Reposition sensor at no additional cost to Owner to avoid conflict between sensor and object obscuring its view, and between sensor and both interior and exterior lighting that causes daylighting controls to repeatedly increase and decrease in brightness (i.e. "cycling").
   4. Field wire photocell for correct footcandle range.

G. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaries.

H. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 32 degrees F to 104 degrees F.
   2. Relative Humidity: Maximum 90 percent, non-condensing.

I. Lighting control system must be protected from dust during installation.

J. Prior to applying continuous dimming daylighting controls, maintain fluorescent lighting at full output for a minimum of 100 hours. If this is not done, replace lamps and ballasts of affected luminaires at no cost to Owner.

K. Use manufacturer’s published testing and adjusting procedures to adjust sensor time delay, daylight sensitivity, and passive infrared sensitivity to satisfaction of Owner.

L. Reposition sensor at no additional cost to owner to avoid conflict between sensor and object obscuring its view, and between sensor and both interior and exterior lighting that causes daylighting controls to repeatedly increase and decrease in brightness (i.e. “cycling”).

M. Systems Integration:
   1. Equipment Integration Meeting Visit:
      a. Facility Representative to coordinate meeting between Facility Representative, Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures.

3.02 STARTUP AND PROGRAMMING

A. Provide factory-certified field service engineer to ensure proper system installation and operation under following parameters:
   1. Qualifications for Factory-Certified Field Service Engineer:
      a. Minimum experience of 2 years training in the electrical/electronic field.
      b. Certified by the equipment manufacturer on the system installed.
   2. Site Visit Activities:
      a. Verify connection of power feeds and load circuits.
      b. Verify connection of controls.
      c. Verify system operation control by control, circuit by circuit.
      d. Obtain sign-off on system functions.
      e. Demonstrate and educate Owner’s representative on system capabilities, operation and maintenance

B. Tech Support: Provide factory direct technical support hotline 24 hours per day, 7 days per week.

3.03 FIELD QUALITY CONTROL

A. Manufacturer Services:
   1. Aim and Focus Visit:
      a. Facility Representative to coordinate on-site meeting with Lighting Control System Manufacturer and Lighting Design Consultant to make required lighting adjustments to the system for conformance with the Lighting Design Consultant's original design intent.

3.04 CLOSEOUT ACTIVITIES

A. Training Visit: Lighting Control System Manufacturer to provide 1 day additional on-site system training to site personnel no less than 2 months after Substantial Completion, separate from start-up and programming visit.

B. On-Site Walk Through: Lighting Control System Manufacturer to provide a factory certified Field Service Engineer to demonstrate system functionality to the Commissioning Agent.

C. Test lighting controls to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with Drawings and Specifications. Provide functional testing of sequences of operation to ensure operation in accordance with Drawings and Specifications. Provide complete report of test procedures and results to engineer and insert approved copy into project closeout documents.

D. Testing Includes:
   1. Daylight automatic controls.
   2. Occupant sensing automatic controls.
   3. Automatic time and override controls for interior lighting.
   4. Automatic time and photo controls for exterior lighting.

3.05 MAINTENANCE

A. Capable of providing on-site service support within 24 hours as part of Warranty and Maintenance Plan.

B. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system startup separate from Construction Contract.

C. System Optimization Visit: Lighting Control System Manufacturer to visit site 6 months after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will fit with the current use of the facility.

END OF SECTION

SECTION 26 2416
PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Power Distribution Panelboards
   2. Panelboards
   3. Surge Protective Devices

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:
   1. Section 26 24 13, Switchboards.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. UL 67, Standards for Panelboards.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Eaton Electric

B. GE Industries

C. Square D

D. Or approved equivalent.

E. Manufacturers listed above are allowed on condition of meeting specified conditions including available space for equipment, Code required working clearances, and selective coordination per Section 26 0573, Electrical Distribution System Studies can be met. Prior to submitting bid, manufacturer to provide documentation to Engineer verifying specific conditions, including those mentioned above, can be met. Remove and replace electrical equipment installed, at no cost to the Owner, that does not meet these conditions.

F. Basis of Design: Square D. Manufacturers listed are allowed on condition of meeting specified conditions including available space for the equipment and Code required working clearances and selective coordination per Section 26 0573, Electrical Distribution System Studies. Remove and replace electrical equipment installed that does not meet these conditions at no cost to Owner.

2.02 POWER DISTRIBUTION PANELBOARDS

A. Description: NEMA PB 1 Type 1 or Type 3R, circuit breaker type.

B. Integrated Equipment Rating: Provide fully rated integrated equipment rating greater than the available fault current. Series rated panelboards are or are not acceptable. Reference drawings for available fault current. If drawings do not have available fault current shown, then coordinate with serving electrical utility. Final rating based on the protective device study completed under the provisions of Division 26, Electrical Distribution System Studies.

C. Panelboard Bus: Non-reduced Copper, ratings as indicated on drawings. Bus bar with suitable electroplating (tin) for corrosion control at connection. Provide copper ground bus in each panelboard.

D. Lugs: Mechanical type for both aluminum and copper conductors.

E. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.

F. Molded Case Circuit Breakers with Current Limiters: With replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole; UL listed.

G. Current Limiting Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole: UL listed. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

H. Solid-State Molded Case Circuit Breakers: With electronic sensing, timing and tripping circuits for adjustable current settings; UL listed.
   1. Ground fault trip, ground fault sensing integral with circuit breaker.
   2. Instantaneous trip.
   3. Adjustable short time trip.
   4. Adjustable long time delay.
   5. Adjustable short time delay.
   6. Adjustable short time pickup.
   7. Stationary mounting.
   8. Include shunt trip where indicated.

I. Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower, with bimetal overload relay.
   1. Coil operating voltage: 120 volts, 60 Hz.
   2. Size as shown on Drawings.
   3. Provide unit mounted control power transformer, RED indicating light in front cover.

J. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

K. Fully equip unused spaces for future devices, including manufacturer required connections and mounting hardware.

L. Cabinet Front: Surface type hinged door in door construction with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.

2.03 PANELBOARDS

A. Description: Panelboards 400 amps or less. NEMA PB1, Type 1 as indicated on drawings, circuit breaker type. Maximum enclosure depth: 6-inches for surface mounted, 5 3/4-inches for flush mounted.

B. Maximum Width: 20-inches.

C. Integrated Equipment Rating: Provide fully rated integrated equipment rating greater than the available fault current. Series rated panelboards are or are not acceptable. Reference drawings for available fault current. If drawings do not have available fault current shown, then coordinate with serving electrical utility. Final rating based on the protective device study completed under the provisions of Division 26, Electrical Distribution System Studies.

D. Panelboard Bus Non-Reduced: Copper, ratings as indicated on drawings. Bus bar with suitable electroplating (tin) for corrosion control at connection. Provide copper ground bus in

each panelboard; provide isolated ground bus where scheduled. Provide 200 percent rated copper neutral bus where scheduled.

E. Lugs: Mechanical type for both aluminum and copper conductors.

F. Provide double lugs and/or feed-through lugs for feed through feeders.

G. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, plug-in type, with common trip handle for poles; UL listed. Predrill bus for bolt-on breakers.
   1. Type SWD for lighting circuits.
   2. Type HACR for air conditioning equipment circuits.
   3. Class A ground fault interrupter circuit breakers where scheduled.
   4. Class B ground fault equipment protection circuit breakers for heat trace and other circuits as required by Code. Provide shunt trip circuit breakers where scheduled; provide wiring to remote trip switch/contacts as indicated on Drawings.
   5. Do not use tandem circuit breakers.
   6. Combination AFCI Breaker: UL 1699 compliant. Integral 30mA GFCI trip. Manual test button for AFCI mechanism. Self-testing, tripping if AFCI module fails.

H. Current Limiting Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole; UL listed. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

I. Solid-State Molded Case Circuit Breakers: With electronic sensing, timing and tripping circuits for adjustable current settings; UL listed.
   1. Ground fault trip, ground fault sensing integral with circuit breaker.
   2. Instantaneous trip.
   3. Adjustable short time trip.
   4. Adjustable long time delay.
   5. Adjustable short time delay.
   6. Adjustable short time pickup.
   7. Stationary mounting.
   8. Include shunt trip where indicated.

J. Accessories: Provide where indicated: shunt trip, arc-fault circuit interrupter (AFCI), Class A ground fault circuit interrupter (GFCI), auxiliary switch and alarm switch.

K. Cabinet Front: Provide flush or surface mounting as shown on the schedules, drawings, or otherwise noted. Cabinet front with concealed hinged front cover door-in-door construction, metal directory frame with heavy clear plastic protector, flush lift latch and lock, two keys per panel all keyed alike.

L. Provide boxes with removable blank end walls and interior mounting studs. Provide interior support bracket for ease of interior installation.

M. Furnish surface mounted cabinet boxes without knockouts.
   1. Minimum Integrated Short Circuit Rating:
      a. 10,000 amperes symmetrical for 240 V panelboards.
      b. Minimum rating as indicated on the Drawings or Panel Schedules.

2.04 SURGE PROTECTIVE DEVICES

A. See 26 43 00, Surge Protective Devices (SPD).

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1, NECA 1 and manufacturers installation instructions.

B. Install panelboards level and plumb. Install recessed panelboards flush with wall finishes.

C. Height: 6-feet 6-inches to top of panelboard; install panelboards taller than 6-feet 6-inches with bottom no more than 4-inches above floor.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard. Include all "spaces" and "spares." Revise directory to reflect circuiting changes and as-installed conditions. Use final Owner designated room names and numbers, and not designations shown on drawings.

F. Provide engraved plastic nameplates per Section 26 05 53, Identification for Electrical Systems.

G. Provide arc flash labels per Section 26 0573, Electrical Distribution System Studies.

H. Provide 2 (qty), 3/4-inch spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.

I. Provide permanent identification number in or on panelboard dead-front adjacent to each breaker pole position. Horizontal centerline of numbers to correspond with centerline of circuit breaker pole position.

J. Ground and bond panelboard enclosure per NEC. Bond panelboards in patient care areas per NEC 517.

K. Paint:
   1. Standard factory finish unless noted otherwise.
   2. Panelboards located in finished interior areas in view of building occupants: paint to match adjacent wall surface. Color and paint preparation as specified by Architect. Covers to be painted off wall, then installed over dried, painted wall surface.

L. Provide handle guards on each circuit supplying obviously constant loads such as fire alarm, security, lighting controls, refrigerators and freezers, fire protection, etc.

M. Breakers being added to existing panelboards: Coordinate breaker type and short circuit rating with existing panelboard. Breakers to match existing in manufacturer's type and AIC rating. Provide new typed circuit directory.

N. Provide handle tie to branch circuit breakers of multiwire branch circuits for simultaneous disconnection of circuits. Handle tie will be identified for use with circuit breakers provided. Reconfigure assigned circuits as necessary so that circuit breakers associate with multiwire branch circuits are physically adjacent, record changes in panelboard schedules and circuiting plans for record drawings.

O. Provide interior wiring diagram, neutral wiring diagram, UL label, and short circuit rating on interior or in booklet format inserted in sleeve inside panel cover.

P. Verify available recessing depth and coordinate wall framing with other divisions.

Q. Shunt Trip Circuit Breakers: Provide wiring to remote trip switch/contacts as indicated on Drawings.

R. Maintain fire rating of wall where panels are installed flush in fire rated walls.

3.02 FIELD QUALITY CONTROL

A. Perform inspections and tests in accordance with manufacturer's requirements.

3.03 ADJUSTING

A. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

3.04 CLEANING

A. Thoroughly clean exterior and interior of each panelboard in accordance with manufacturer's installation instructions.

B. Vacuum construction dust, dirt, and debris out of each panelboard.

C. Where enclosure finish is damaged, touch up finish with matching paint in accordance with manufacturer's specifications and installation instructions.

END OF SECTION

SECTION 26 2726
WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included: Provision of materials, installation and testing of:
   1. Wall Switches
   2. Receptacles
   3. Finish Plates
   4. Wall Dimmers
   5. Surface Covers

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. UL 498, Attachment Plugs and Receptacles.
   2. UL 943, Ground Fault Circuit Interrupters (Class A GFCI).
   3. UL 1472, Standard for Solid State Dimming Controls.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Wall switches and Dimmers
   2. Receptacles
   3. Wall Plates
   4. In-Use Cover

C. Submit performance test results for devices in patient care areas in conformance with NFPA 99-4.3.3.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Wall Switches:
   1. Toggle Type Characteristics:
      a. Leviton LEV-LOK
      b. Hubbell Quick-Tech
      c. Or approved equivalent.
   2. Timer Switches:
      a. WattStopper TS-400
      b. Or approved equivalent.
   3. Key Switches:
      a. Pass & Seymour PS20AC1-L
      b. Hubbell HBL 1221-L

c. Leviton 1221-2L
d. Or approved equivalent.

B. Receptacles:
1. Commercial Grade - 20 Amp:
a. Leviton LEV-LOK
b. Hubbell Quick-Tech
c. Or approved equivalent.
2. Ground Fault Circuit Interrupter (GFCI) Receptacle:
a. Leviton LEV-LOK
b. Hubbell Quick-Tech
c. Or approved equivalent.
3. While-in-Use Weatherproof Cover:
a. Die Cast Cover:
1) Intermatic
2) Hubbell
3) Cooper
4) Or approved equivalent.

C. Wall Dimmers:
1. Lutron NT Series
2. Or approved equivalent.

D. Surface Covers:
1. Aluminum with Gasket, Blanks, Single Gang:
a. Bell 240-ALF
b. Carlon
c. Or approved equivalent.
2. 2-Gang:
a. Bell 236-ALF
b. Carlon
c. Or approved equivalent.

E. Provide lighting switches and receptacles of common manufacturer and appearance.

2.02 WALL SWITCHES

A. Characteristics: Toggle type, quiet acting, 20 amp, 120/277 volt, UL listed for motor loads up to 80 percent of rated amperage, extra heavy duty.

B. Timer Switches: Digital time switch to automatically turn light off after set time. Adjustable time setting from five minutes to 12 hours. LCD to show time remaining. 20-amp/120 to 277 volt.

C. Key Switches: 20 amp/120-277 volt, black key guide.

D. Finish: White.

2.03 RECEPTACLES

A. Duplex Receptacles Characteristics: Straight parallel blade, 125 volt, 2 pole, 3 wire grounding.
1. Commercial Grade: Riveted. Back and side wired. Brass ground contact on steel strap. Nylon face and nylon base. 20 amp.

B. Ground Fault Circuit Interrupter (GFCI) Receptacle: Feed through type, back-and-side wired, tamper-resistant, weather resistant self-testing, 20 amp, 125VAC.

C. While-in-Use Weatherproof Cover: NEMA 3R when closed over energized plug. Vertical mount for duplex receptacle. Provide continuous use cover with cover capable of closing over energized cord cap with bottom aperture for cord exit.
1. Die cast cover with closed cell neoprene foam gasket: Capable of being locked closed to prevent tampering or unauthorized use.

D. Special Purpose Receptacles: Reference Drawings for NEMA Standard Specification.

E. Finish:

1. Same exposed finish as switches.
2. Receptacles connected to emergency circuits life safety and critical to have red finish.
3. Receptacles installed in surface raceway to match raceway finish. See Section 260533, Raceways.

2.04 FINISH PLATES

A. Finish Plates: Type 302 stainless steel. Smooth satin finish..

B. Provide telephone/signal device plates; activated outlets to have coverplates to match modular jack.

C. Provide emergency devices with factory engraved "Emergency."

2.05 WALL DIMMERS

A. Provide wall dimmers compatible with type of load controlled (i.e. line voltage, low voltage, 2-wire, 3-wire, 0-10v). Finish to match wall switches. Size dimmers to accept connected load. Do not cut fins. Where dimmers are ganged together, provide a single multi gang coverplate.

2.06 SURFACE COVERS

A. Material: Galvanized steel, 1/2-inch raised industrial type with openings appropriate for devices installed on surface outlets.

B. Cast Box and Extension Adaptors: Aluminum with gasket, blanks single gang or 2-gang.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protection:
   1. Devices: Upon installation of finish plates and receptacles, adhere to proper and cautious use of convenience outlets. At time of substantial completion, replace those items which have been damaged, including those burned and scored by faulty receptacles or cord caps.
   2. Finish Plates and Devices: Do not install items until finish painting is complete. Scratched or splattered finish plates and devices not acceptable.

3.02 INSTALLATION

A. See Architectural elevations for location and mounting height of wiring devices. Review Architectural elevations prior to rough-in and contact Architect immediately if conflicts are found between Architectural and Electrical Drawings. Do not rough-in devices until conflicts are resolved.

B. Install wiring devices and finish plates plumb with building lines, equipment cabinets and adjacent devices. Devices not plumb will be fixed at no additional cost to Owner.

C. Orientation:
   1. Wall-Mounted Receptacles: Install with long dimension oriented vertically at centerline height shown on drawings or as specified.
   2. Vertical Alignment: When more than one outlet is shown on drawings in close proximity to each other, but at different elevations, align outlets on a common vertical center line for best appearance. Verify with Architect.
   3. Horizontal Alignment: When more than one outlet is shown on Drawings to be stacked in wall vertically, align outlets on a common horizontal center line for best appearance. Verify with Architect.

D. GFCI Outlets: One GFCI receptacle may be used to provide GFCI protection to downstream duplex receptacles on same branch circuit. If GFCI receptacle is used, the following conditions must be met:
   1. Downstream receptacles are in same room as upstream GFCI duplex receptacles.
   2. Downstream duplex receptacles are labeled as being protected by an upstream GFCI receptacle in same room.

E. Provide 20 amp rated duplex receptacle in conditions where there is only one duplex receptacle on a 20 amp branch circuit.

3.03 LABELING

A. Provide labeling per Section 26 05 53, Identification for Electrical Systems.

B. Provide receptacle device plates with panel and circuit designation labeled on the face, with Dymo-type label, and with circuit written in permanent marker on back of plate and back-box. Provide switch device plates with panel and circuit designation written in permanent marker on back of plate and back-box.

3.04 TESTING

A. Submit report of compliance and results of receptacle and equipment tests:

B. Test wiring devices to ensure electrical continuity of grounding connections, and after energizing circuitry, to demonstrate compliance with requirements. Test receptacles for line to neutral, line to ground and neutral to ground faults. Correct any defective wiring.

END OF SECTION

SECTION 26 2800
OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Fuses
   2. Molded Case Circuit Breakers

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product data and instantaneous let-through current curves and average melting time current curves for fuses supplied to project.
   2. Product data and time/current trip curves for circuit breakers supplied to project.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Fuses:
   1. Bussmann
   2. Ferraz-Shawmut
   3. Littelfuse
   4. McGraw-Edison
   5. Or approved equivalent.

B. Circuit Breakers:
   1. Eaton Electrical
   2. General Electric
   3. Square D
   4. Or approved equivalent.

2.02 FUSES

A. Characteristics:
   1. Dual element, time delay, current limiting, nonrenewable type, rejection feature.
   2. Combination Loads: UL Class RK1, RK5, or J, 1/10 to 600 amp. UL Class L, above 600 amps.
   3. Motor Loads: UL Class RK5, 1/10 to 600 amp.
   4. Fuse pullers for complete range of fuses.

2.03 MOLDED CASE CIRCUIT BREAKERS

A. 1-, 2- or 3-pole bolt-on, single handle common trip, 600VAC or 250VAC as indicated on Drawings.

B. Overcenter toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.

C. Calibrate for operation in 40 degrees C ambient temperature.

D. 15 to 150 Amp Breakers: Permanent trip unit containing individual thermal and magnetic trip elements in each pole.

E. 151 to 400 Amp Breakers: Adjustable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.

F. Greater than 401 Amp: Electronic trip type with adjustments for long-time, instantaneous, and short-time functions.

G. Combination AFCI Breaker: UL 1699 compliant. Integral 30mA GFCI trip. Manual test button for AFCI mechanism.

PART 3 - EXECUTION

3.01 COORDINATION

A. Obtain and review the submitted product data for equipment furnished by the Owner, and furnished under other Divisions of this contract, particularly under Divisions 22 and 23.

B. Confirm the equipment nameplate maximum overcurrent protection (MOCP) and make accommodations and adjustments to overcurrent protective devices as necessary to coordinate with the nameplate rating.

3.02 INSTALLATION

A. Fuses: For each class and ampere rating of fuse installed, provide the following quantities of spares for quantity of fuses installed:
   1. 0 to 24: Provide 6 spare.
   2. 25 to 48: Provide 9 spare.
   3. 49 and Above: Provide 12 spare.

B. Provide testing of ground fault interrupting breakers.

C. Circuit Breakers:
   1. Provide circuit breakers, as specified and on Drawings, for installation in panelboards, individual enclosures or combination motor starters.
   2. Provide ground fault interrupter circuit breakers for equipment in damp or wet locations.
   3. Provide device on handle to lock breaker in "ON" position for breakers feeding time switches, night lights and similar circuits required to be continuously energized.
   4. Shunt Trip Circuit Breakers: Provide wiring to remote trip switch/contacts as indicated on Drawings.
   5. Provide multi-pole branch circuit breakers for multiwire branch circuits for simultaneous disconnection of circuits.

END OF SECTION

SECTION 26 2816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Toggle Type Disconnect Switches
   2. Safety Switches

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Toggle Type Disconnect Switches:
   1. Cooper
   2. Hubbell
   3. Leviton
   4. Pass & Seymour
   5. Slater
   6. Or approved equivalent.

B. Safety Switches:
   1. Eaton Electrical
   2. GE Industrial
   3. Square D
   4. Or approved equivalent.

2.02 TOGGLE TYPE DISCONNECT SWITCHES

A. Rating: 120 or 277 volt, 1 or 2 pole, 20 amp, 1 hp maximum.

B. Enclosure:
   1. NEMA 1: Dry locations/Indoors.
   2. NEMA 3R: Damp or wet locations/Outdoors.

C. Handle lockable in 'off' position.

2.03 SAFETY SWITCHES

A. Heavy duty fusible type and non-fusible type (as indicated on drawings), dual rated, quick-make, quick-break with fuse rejection feature for use with Class R fuses only, unless other fuse type is specifically noted.

B. Clearly marked for maximum voltage, current, and horsepower.

C. Operable handle interlocked to prevent opening front cover with switch in 'on' position.

D. Switches rated for maximum available fault current.

E. Handle lockable in 'off' position.

F. Enclosure:
   1. NEMA 1: Dry locations/Indoors.
   2. NEMA 3R: Damp or wet locations/Outdoors.

PART 3 - EXECUTION

3.01 COORDINATION

A. Obtain and review the submitted product data for equipment furnished by the Owner, and furnished under other Divisions of this contract, particularly under Divisions 22 and 23.

B. Confirm the equipment nameplate maximum overcurrent protection (MOCP) and make accommodations and adjustments to switches, fuses and circuit breakers as necessary to coordinate with the nameplate rating

3.02 INSTALLATION

A. Provide disconnecting means within sight of each motor controller and of each motor. Motor controller disconnecting means equipped with lock-out/tag-out padlock provisions do not require a disconnect switch at the controlled motor location. Locate disconnect means in view of and not inside of equipment, such that tools are not needed to remove covers to access the disconnecting means.

B. Install in accordance with manufacturer's instructions.

C. Install fuses in fusible disconnect switches. Coordinate fuse ampere rating with installed equipment. Do not provide fuses of lower ampere rating than motor starter thermal units.

D. Provide engraved nameplates per Section 26 05 53, Identification for Electrical Systems.

E. Provide arc flash labels per Section 26 05 73, Electrical Distribution System Studies.

F. Apply neatly typed adhesive tag on inside door of each fusible switch indicating NEMA fuse class and size installed.

END OF SECTION

SECTION 26 3100
PHOTOVOLTAIC SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. PV Module and Array Specifications (Base Bid PV System)
   2. Grid-Interactive Inverter (GII) and Utility Interconnections
   3. Communications

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition provide:
   1. Overview of major system components and principals of operation.
   2. Complete parts lists, including electrical components, mechanical hardware and other equipment required for installing the systems. (Must include description, make, model/part number and source for the equipment provided.)
   3. Diagram indicating overall layout of entire system, including PV array, and location of GII and combiner boxes with respect to the array.
   4. Electrical schematics and diagrams showing major components and devices, including conductor types and sizes, connections of individual modules and array source circuits, terminations at junction boxes, connection to surge suppression devices and the GII, and the GII interface with the utility grid.
   5. Mechanical drawings showing details of module/array mechanical support structure and instructions for assembling and installing arrays on rooftops.
   6. Complete assembly and installation instructions for mounting array, junction boxes and enclosures, routing conduit, wiring arrays, and terminating conductors at array, combiner boxes and GII.
   7. Procedures for operating, disconnecting, servicing and maintaining complete system and individual components.
   8. Warranty information on individual components as required in this bid document.
   9. Equipment manufacturer's specifications and operations manuals, including those for PV modules, GII, overcurrent devices, disconnects and optional equipment
   10. Qualifications for installer(s), including minimum 5 grid-interactive PV projects of minimum 15 kilowatts at STC within 200 miles of the project site.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. IEEE Standards Coordinating Committee 21, IEEE 1547 Standard for Interconnecting Distributed Resources with Electrical Power Systems.
   2. Underwriters Laboratories, Standard for Safety: Flat-Plate Photovoltaic Modules and Panels, Standard UL 1703.
   3. Underwriters Laboratories, Standard for Safety: Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources, Standard UL 1741.

4. System designed and installed by a qualified installer with a minimum of 5 years of experience in installation of commercial photovoltaic systems.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Provide minimum 20 year warranty on power output of PV modules.
   2. Provide GII with minimum 10 year replacement warranty from the manufacturer covering parts and labor.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Base Bid PV Modules:
   1. Mono/Polycrystalline Modules:
      a. Solar World Sunmodule Series
      b. Panasonic HIT Series
      c. Sunpower X-Series
      d. Sharp ND Series
      e. Or approved equivalent.

B. Base Bid Inverters:
   1. Central Inverter for 25kW maximum net metered system:
      a. Fronius Symo 24.0-3 480
      b. Solectria PVI 23TL
      c. SMA Sunny Tripower 2400TL-US
      d. Or approved equivalent.
   2. Micro Inverters (for generation metered system up to 200kW maximum:
      a. Enphase C250
      b. Or approved equivalent.

2.02 PV MODULE AND ARRAY SPECIFICATIONS

A. PV Modules: monocrystalline or polycrystalline.

B. PV array size to meet Oregon Administrative Rules for 1.5 percent Green Energy Technology in Public Buildings. Based on current market pricing we anticipate a total system size of 92.5kW depending on final budgetary costs.

C. PV modules, array and racking system to meet all Energy Trust of Oregon Solar Electric Installation Requirements.

2.03 GRID-INTERACTIVE INVERTER (GII) AND UTILITY INTERCONNECTION

A. Design with GII built specifically for grid-interactive connection photovoltaic arrays to utility, and capable of automatic, continuous, and stable operation over the range of voltages, currents, and power levels for the size and type of arrays used.

B. Provide each GII to be compliant with IEEE 1547 (Standard for Interconnecting Distributed Resources with Electric Power Systems) and meet UL1741 (Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources) or equivalent product listing. GII to comply with the latest applicable ANSI and FCC standards and addenda dated prior to the award of the purchase order for this procurement.

C. Provide GII with communications connection for remote monitoring of inverter operation through the internet. Provide and configure software for receiving and tabulating this information through a graphic user interface accessible over the internet. Provide communications card in each GII to allow daisy-chained RS-485 connection between GII's, and interface card for internet communications. Software to provide DC voltage, current, power and energy production, AC voltage, current, power and energy production, operational status of the GII, and graphical

record of past production for minimum of 365 previous days on 15 minute increments. Prior to construction, determine location and accessibility to LAN connection point.

D. GII to meet all Energy Trust of Oregon Solar Electric Installation Requirements.

2.04 COMMUNICATIONS

A. Provide internet portal account through inverter manufacturer to allow real time monitoring of total system and individual inverter power and energy production, with logs going back to at least 365 days.

B. Portal interface:
   1. In bar graph, show power (watts) and energy (kilowatt-hours) production on hourly basis for one day, daily basis for one month, and daily basis for one year. Provide means to examine past power and energy production for at least the previous 365 days.
   2. Program interface to allow end user to examine power and energy production for the total site, as well as for each individual GII.
   3. Supplemental Display Information: Show PV system size in KW, maximum output production in KW, quantity and manufacturer/model of GII and quantity and manufacturer of PV modules, installation date.
   4. Lifetime Energy Production: Show lifetime total equivalents (e.g. number of typical residences that could be powered for one day, number of cups of coffee that could be brewed with same energy, gallons of gasoline offset, etc.).
   5. Greenhouse Gas Offsets: Show offset quantities for clean energy produced (example: weight of carbon dixoide, nitrogen oxides, sulfur oxides).
   6. Environmental Information: Show current ambient temperature, cell temperature, irradiance, wind speed and direction.
   7. Integration of Other Meters: Show power and energy consumption from sub-metering on main electrical service; see Drawings for locations. Provide and connect to Veris H8163 Series and matching split-core CT.

PART 3 - EXECUTION

3.01 SYSTEM DESCRIPTION

A. These specifications cover the design and procurement of equipment, hardware and documentation required for the installation of grid-connected PV systems.

B. Provide complete system installation, in addition to documentation on the design, configuration, permit acquisition, installation, operation and maintenance of the complete system and individual components.

C. System designed for installation in Eugene, Oregon. Supplied equipment must be rated and warranted to withstand and operate under normal weather conditions at the site.

D. Each PV system will be connected to the utility electric grid through a grid-interactive power conditioner (inverter). The design and functional specification of the PV modules, power conditioners, utility interconnections, PV system electrical design, and PV array mechanical design are described in the following Sections.

E. Utility Coordination: Coordinate with local Utility Company prior to start of work for location of their net metering equipment, including CT enclosure provided under this Contract per the Drawings, and any additional utility required disconnects which will also be provided under this Contract. Identify all permits/applications required of serving utility and complete, or assist owner with completion of such documents.

3.02 PV SYSTEM ELECTRICAL DESIGN

A. Provide electrical design and installation instructions for the PV systems conforming to the NEC. Article 690 of the NEC applies specifically to photovoltaic system safety, protection, control and interface with other sources. Other articles of NEC also apply. Comply with IEEE 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems and the Energy Trust of Oregon Solar Electric Installation Requirements.

B. Electrical components, including overcurrent protection, disconnects, surge suppression devices, conduit, wiring and terminals must have UL or equivalent listing and have appropriate voltage, current and temperature ratings for the application. Special attention should be given to appropriate ratings for components used in DC circuits.

C. Wiring must be listed for 1,000VDC and 600VAC, and a temperature rating of 90C in wet locations. The use of exposed conductors or cabling (excluding grounds) is not acceptable, except MC cable connectors installed under PV modules. Exposed conduit to be painted to match surrounding area. Confirm color with Architect.

D. Ampacity calculations must take into account appropriate deratings as required. Conductors in the system are subject to a 125 percent NEC derate, and DC source circuit conductors and overcurrent devices must include an additional 125 percent derate for solar radiation enhancements. Appropriate temperature deratings for conductors used in module junction boxes must be considered for peak module operating temperatures, as well as deratings for instances where more than three current-carrying conductors are enclosed in a conduit.

E. Voltage drop in array DC source circuits should be limited to no more than 2 percent, including losses in conductors, and through all fuses, blocking diodes and termination points.

F. Overcurrent devices must have trip ratings no greater than the derated ampacity of the conductors that it protects.

G. Series connected strings of modules (source circuits) must include a series fuse as required by UL and NEC to prevent excessive reverse current flow through modules in source circuits. Parallel connections of modules in individual source circuits are not permitted. Parallel-connected cells within individual modules are allowable as long as the module listing allows for the series fuse required for this configuration.

H. Series connected strings of modules (source circuits) must also include a blocking diode to minimize overall array losses due to partial shading of source circuits. These diodes should have low voltage drop to meet the requirements above, and have a voltage and current ratings (at temperature) at least twice the open circuit voltage and short-circuit ratings of the source circuits.

I. Terminations must use listed box terminal or compression type connections. Twist on wire splices, crimped, soldered or taped connections are not permitted for the required field installed wiring. Proper torque specifications should be provided for the required field connections.

J. Module frames, metal enclosures, panel boards and the grid-interactive inverter (GII) should be provided with connections for bonding to a common grounding conductor and terminating at the ground electrode system at the utility service entrance point. In addition, provide for grounding the neutral of the GII output. The DC negative circuit may be common to the AC neutral in the GII design and under no circumstances should multiple connections to ground be specified for current carrying conductors in the system.

K. Provide a weathertight, vented, locking, pad mountable enclosure, suitable for housing the GII, AC/DC disconnect devices, and source circuit combiner boxes (as required). Enclosure rating: NEMA 4, 3R or better and have superior strength and corrosion resistance properties based on the project location.

3.03 PV ARRAY MECHANICAL DESIGN

A. Provide hardware as required for assembling the photovoltaic modules and panels, and structurally attaching them to the base support structure.

B. Coordinate PV array and equipment mounting with PV system mounting structures shown on Structural Drawings. Where array and supporting equipment deviate from Basis of Design, include cost of engineering services to update Structural Drawings and Structural Installation for submitted design. Array design that requires modification of building structure in addition to structure supporting PV array and equipment is not acceptable under this Contract.

C. Provide panel layout design with firefighter access and egress paths per local Codes.

D. Include a 36-inch wide pathway maintained along three sides of the solar roof. Exceptions to comply with Oregon Solar Installation Specialty Code. For arrays larger than 150-feet, measured in length or width, to have a 36-inch intermediate pathway for service, maintenance and egress. Disconnects, junction boxes, combiner boxes or gutters not to be located in any required pathway or cutout.

E. Array mounting hardware supplied by the bidder to be compatible with the site considerations and environment. Minimize risk from exposed fasteners, sharp edges, and potential damage to the modules or support structure. Emphasize corrosion resistance and durability of the mechanical hardware. Avoid use of ferrous metals, contact of dissimilar metals or wood or plastic components.

F. As these are high profile, publicly visible installations, the aesthetics of the overall installation is extremely important to the Owner. To create a uniform appearance of the array, spacing between individual modules and panels should be kept to a minimum. As much as possible, conceal mechanical hardware, conduit, junction boxes and other equipment beneath and/or behind the array.

G. Be consistent with the ordering and labeling of source circuits in the array combiner boxes. Ease of access for array troubleshooting and maintenance is desired by allowing access to the back of the array for module junction box servicing, and removal/replacement of individual source circuits and modules if necessary.

3.04 INSTALLATION

A. Grid-Interactive Inverter:
   1. Provide fusing for incoming strings.
   2. Clean interiors and ensure airways for convective cooling are clear and debris-free.
   3. Verify that inverter display measures for AC voltage match measurement from a true-RMS AC digital voltmeter.
   4. Check that maximum power point tracking circuit is operational. Monitor array voltage from open circuit condition until it reaches a point where system power peaks and then starts to drop again. Provide chart of field measurements input and output voltage and current through the day as part of O&M manual.
   5. Provide factory required clearances and air space for cooling and ventilation.

B. Photovoltaic System Wiring:
   1. Field connections: Use crimp-on connectors that maintain connection even when screw loosens.
   2. Size wiring from inverter to PV modules based on less than 2 percent voltage drop in any string.
   3. Conceal flexible conduit and MC cable to underneath the PV modules. Outside of the PV modules, use rooftop conduit per Division 26, Electrical.
   4. PV module wiring to be secured to run parallel and perpendicular to module frame lines, as well as be secured to module and module support structure. Do not allow PV module wiring to rest unsupported against the roof surface.
   5. Provide strain reliefs and cable clamps on cable and cords for PV modules.
   6. Retorque terminations prior to completion of construction.

C. Grounding:
   1. Verify that one connection to DC circuits and one connection to AC circuits is being used for system grounding referenced to the same point. Bond to buildings main grounding system.
   2. Provide bonding for non-current carrying metal parts to ensure they are grounded properly.
   3. Grounding electrode to be installed in accordance with NEC Article 250.122 (AC) but not smaller than #6 AWG copper.

D. Signage:
   1. Post an "Interactive Point of Connection" sign per NEC Article 690.

2. Place a sign at building service entrance indicating type and location of on-site interactive electric power production sources and disconnects per NEC Article 705.
3. At each inverter, post a sign indicating:
   a. Label for Inverter.
   b. Operating current and voltage.
   c. Maximum system voltage.
   d. Short circuit current.

E. Install PV panels, inverter, wiring, protection device as per written installation instructions from the manufacturer.

F. Coordinate mounting of panels with structural engineer and roof system installer prior to submitting design documents.

3.05 TESTING

A. Test each PV panel per manufacturer's written instructions prior to connection to inverter. String level testing is allowed. Document test results and submit in O&M manuals.

B. Test inverters per manufacturer's written instructions. Document test results and submit results with O&M manuals.

3.06 DISPLAY COMMISSIONING AND TRAINING

A. Coordinate with Owner for TCP/IP address for PV communications gateway prior to start of programming.

B. Provide manufacturer supported programming and commissioning services as required for functionality of system as described above. Provide Owner minimum two 2-hour training sessions on separate days with factory support, for use of both internet portal and review installation of communications system. Provide audio/video record of both sessions. Hold either session no less than 30 days from date of substantial completion of the project.

END OF SECTION

SECTION 26 3214
GAS FIRED ENGINE GENERATORS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Rating
   2. Engine and Fuel System
   3. Generator
   4. Generator Control Panel
   5. Transfer Switch
   6. Weatherproof Enclosure

B. System Description:
   1. The engine generator set, in conjunction with the necessary control and accessories, will comprise a complete operating package for KW ratings as shown on drawings for installation at local elevation and ambient temperature extremes (average maximum and average minimum) as recorded by local U.S. Weather Bureau meteorological station.
   2. Provide engine generator set and transfer switches compliant with Level 1 Emergency Power Supply System (EPSS) under NFPA 110.
   3. Provisions and connection of automatic transfer switches to comply with NFPA-76 requirements. Include control wiring with transfer switch for automatic start/stop control to generator control panel equipment.
   4. Provide propane fuel source, unless otherwise noted, including storage, pumps, sensors, piping, venting and other associated equipment.
   5. Provide Connection to Natural Gas: Gas cock, strainer pressure regulator system as shown on Division 23, HVAC Drawings. Piping, fittings and connections for natural gas fuel delivery are executed in accordance with Division 23, HVAC Specifications. This Contract supplies cascaded fuel solenoid valves and local stop cock valve within weatherproof enclosure.
   6. Provide exhaust system in compliance with federal, state, and local environmental air quality standards.
   7. Provide as part of generator assembly, pressure switches, solenoid valves, and programmed engine timing as required to change automatically from natural gas to propane source, and vice versa, based on adequate line pressure of natural gas source.

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. IEEE 446, Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
   2. EN50082-2, Electromagnetic Compatibility - Generic Immunity Requirements, Part 2: Industrial.
   3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Shop Drawings and Product Data for the Following Equipment:
      a. Natural Gas/Propane Engine

b. Natural Gas/Propane Generator
c. Generator Control Panel
d. Remote Alarm Annunciators
e. Transfer Switch
f. Auxiliary Equipment
g. Weatherproof Enclosure

2. Include the Following in Shop Drawing Submittals:
   a. Plans and elevations of the natural gas/propane generator set and weatherproof enclosure and its installation requirements including fuel line equipment and fuel tanks.
   b. Provide contact name, address and estimated distance from site to nearest technical support facility. Service facility must be within 200 miles of project site or approved.
   c. Technical literature describing the natural gas/propane engine generator set performance including certified engine horsepower curves and deratings for project site altitude and ambient temperature conditions.
   d. Drawings and literature describing auxiliary equipment furnished including mounting detail, exhaust and supply ductwork.
3. Operations and Maintenance Data: Provide from system manufacturer authorized local dealer one copy of each of the following manuals and books for each unit under this Contract to the Owner:
   a. Operating Instructions with description and illustration of switchgear controls and indicators and engine and generator controls.
   b. Parts books which illustrate and list assemblies, subassemblies and components, except standard fastening hardware (nuts, bolts, washers, etc.).
   c. Preventative maintenance instructions on the complete system that cover daily, weekly, monthly, biannual, and annual maintenance requirements and include a complete lubrication chart.
   d. Routine Test Procedures for electronic and electrical circuits and for the main AC generator.
   e. Troubleshooting Chart covering the complete generator set showing description of trouble, probable cause, and suggested remedy.
   f. Recommended Spare Parts List showing consumables anticipated to be required during routine maintenance and test.
   g. Wiring Diagrams and Schematics showing function of electrical components.
   h. Contain manuals and books described in rigid plastic pouches.
4. Stamped construction drawings by registered structural engineer in the state of the project site for seismic bracing of the generator set and transfer switch(es) for compliance with IBC seismic requirements for standby and life safety emergency electrical equipment.
5. Provide the following operating and maintenance and instructions from the manufacturer for project closeout, see Project Closeout Requirements in Division 01, General Requirements:
   a. Natural gas/Propane Engine
   b. Natural gas/Propane Generator
   c. Generator Control Panel
   d. Remote Alarm Annunciators
   e. Transfer Switch
   f. Auxiliary Equipment
   g. Weatherproof Enclosure

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Provide generator set that is the product of a manufacturer regularly engaged in the production of this type of equipment and one that has a local distributor and service organization. Configure the generator for single unit operation.
2. Generator supplier is responsible for engine, generator, automatic transfer switches, battery charger, engine block heater, subbase tank, weatherproof enclosure, fuel transfer pumps, automatic start/stop control equipment and circuitry and seismic bracing, so that there is one source of supply and responsibility.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Product Type 1:
   1. Caterpillar
   2. Cummins
   3. Kohler
   4. Katolight
   5. DDC/MTU Power Generation
   6. Elliott Magnatek Power Systems

B. Basis of Design: Generator on Drawings is designed based on Caterpillar product line. Approved manufacturers listed in Part 2 are allowed on condition of meeting the specified conditions including the available space for the equipment (including Code required working clearances). Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.02 RATING

A. Base the rating of the engine generator set on operation of the set when equipped with necessary operating accessories including but not limited to radiator, fan, air cleaners, lubricating oil pump, fuel injection pump, fuel transfer pump, jacket water pump, governor, charging generator, alternating current generator and exciter regulator.

B. Provide the engine generator set capable of producing rated voltage and output continuously for Standby power applications at the ambient temperature and altitude conditions. Provide ratings from the manufacturer's standard published data. Special ratings are not acceptable. Reference Drawings for ratings.

2.03 ENGINE AND FUEL SYSTEM

A. Natural gas driven, spark ignition engine, liquid cooled producing 1.5 HP per KW to operate at 1800 rpm for full electrical output rating. Engine to be mounted to continuous structural steel frame under complete unit.

B. Fuel System:
   1. Provide the engine with a complete fuel system consisting of two cascaded 12VDC solenoid valves, manual gas cock valve, carburetor, fuel strainer, flexible piping and associated piping. Pressure regulator setting and fuel flow criteria is to be coordinated with Division 23, HVAC prior to installation of gas lines.
   2. Provide fully automatic dual fuel system natural gas/L.P. vapor.
   3. Provide flexible fuel supply lines.
   4. Provide a fuel pressure switch on supply side of cascaded solenoid valves. Connect switch as a low fuel supply alarm on pressure drop below minimum supply criteria for engine.
   5. Connect solenoid valves so valves are closed (no fuel flow) when solenoids are deenergized.
      a. Solenoids are energized (fuel flows) when engine start is signaled (both automatically and manually).
      b. Solenoids are deenergized when:

1) Engine stop is signaled (both automatically and manually).
2) Engine is stopped on wait periods of overcrank protection.

C. Fuel and Lubricants: The engines meet requirements specified herein when operating on natural gas fuel. The engines meet requirements specified herein using lubricating oil conforming to MIL-L-2104, viscosity grade as recommended by engine manufacturer.

D. Lubrication:
1. Provide engine with gear-type lubricating oil pump for supplying oil under pressure to the main bearings, pistons, piston points, timing gears, camshaft bearings and valve rocker mechanism.
2. Provide full flow oil filters, conveniently located for servicing. Equip the filter with a spring loaded bypass valve to ensure oil circulation if filters are clogged. Provide a suitable oil cooler as recommended by engine manufacture.
3. Provide an oil drain line extension with manual shutoff valve as part of the engine oil pan.

E. Air Cleaners: Provide the engine with one or more dry type air cleaners.

F. Heaters:
1. The engine liquid cooling system is heated by an auxiliary electric liquid heater to ensure a minimum coolant temperature of 120 degrees F in an ambient of 20 degrees F or 0 degrees F.
2. The engine coolant heater has an automatic control thermostat, overtemperature protection, and oil pressure disconnect switch.

G. The generator stator windings are heated via a direct current flow in two of the 3 phase winding sets while the generator is off. An Allen Bradley Model 1410 motor winding heater is installed on the generator stator windings. Control relays and contactors are provided to disconnect the heating current when the fuel solenoids are energized and to display reconnecting the heating current for 15 minutes after fuel solenoid deenergization.

H. Engine Speed Governing System:
1. Provide electronic governor system with automatic frequency regulation.
2. Control the governing system dynamic capabilities as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions.
3. Actively control the fuel rate and excitation as appropriate to the state of the generator set.
4. Regulate fuel rate as a function of starting, accelerating to start disconnect speed, accelerating to rated speed.
5. Include a programmable warm up at idle and cooldown at idle function. While operating in idle state, disable the alternator excitation system.

I. Batteries and Charger System:
1. Install lead-acid batteries having sufficient capacity for cranking the engine for at least 30 seconds at firing speed in the ambient temperatures specified in these Specifications and with capacity for starting the diesel engine a minimum of four times.
2. Provide the batteries complete with intercell connections and mounted in a metal frame or rack of corrosion resisting metal.
3. Provide the battery charger enclosed (weatherproof if exterior), wall mounted, constant voltage, heavy duty, industrial type designed for operation from 120 volt, 1 phase, 60 Hz, AC power. The charger is suitable for keeping the engine starting batteries in a charged condition during periods when the engine is idle. Rectifier elements are silicon diodes capable of continuous operation at full rated load using convection cooling in ambient temperatures up to 125 degrees F. The charger automatically adjusts from full rated output to trickle charge and from trickle charge to full rated output, depending on the state of charge of the battery. Provide the charger equipped with a voltmeter, ammeter AC and DC circuit protection, voltage surge suppression.

J. Cooling System:

1. Provide the engine with a cooling system having sufficient capacity for cooling the engine when the generator set is delivering full-rated load in the ambient temperature. Install permanent type antifreeze/anticorrosion solution to the coolant for minus 20 degrees F.
2. Equip the engine with an engine driven, centrifugal-type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level.
3. Equip the engine with a radiator and fan of a type and capacity recommended by engine manufacturer. Provide blower fan.
4. Where remote cooling is mentioned on Drawings, the generator set includes cooling fluid pumps, cooling radiator, fan motors, fans, including wiring and control. Auxiliary pumps and fan motors are monitored on required annunciator and generator control points with illuminated trouble lamps indicating when they fail to function.
5. Exhaust System: Provide suitable silencer of the critical residential type, with the engine. Use stainless steel, flexible exhaust pipe from engine exhaust to silencer. Provide exhaust opening rain guard. Support silencer independent of engine.

2.04 GENERATOR

A. Rating:
1. The generator is capable of producing rated voltage and output at 0.8 power factor based upon site conditions of altitude and ambient temperatures.
2. Provide the generator rating applicable for continuous service in standby power application. Maximum voltage dip on full load and power factor is 15 percent.
3. Temperature Rise: 80 degrees C above 40 degrees C ambient.
4. Construction:
   a. Provide the generator with a revolving field, single bearing type, coupled directly to the engine flywheel through a flexible driving disc for positive alignment. Provide the rotor dynamically balanced up to 25 percent overspeed.
   b. Provide the generator of heavy duty, compact design. The insulation is Class H or better, as recognized by NEMA MG-1. The generator is equipped with full amortisseur windings for paralleling.
5. The generator field excitation is performed by 3-phase full wave bridge rectifier mounted on rotor shaft.
6. Provide microprocessor based digital voltage regulator with fully programmable operating and protection characteristics. Regulator capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode. Alternator output voltage adjustable between -10 percent and +10 percent of nominal.
7. Provide generator output circuit breaker integral to generator output terminal enclosure. Remote annunciator panel to monitor breaker and report a trouble signal when open.
8. Generator Set Performance:
   a. Provide the voltage regulation from no load to rated load within a band of plus or minus 0.5 percent of rated voltage. The steady state voltage stability remains within a 0.5 percent band of rated voltage. Steady state voltage modulation does not exceed 1 cycle per second.
   b. For addition of load up to and including 100 percent of rated load, the voltage dip does not exceed 15 percent of rated voltage. The voltage recovers to and maintains within the steady band in not more than 1.5 seconds.
   c. Frequency Regulation: Steady state no load to steady state rated load. Random frequency variation with any steady load not-to-exceed plus or minus 0.5 percent. For addition of load up to 90 percent of rated load, the frequency recovers to the steady state frequency band within 5 seconds.
   d. Alternator to produce a clean AC voltage waveform, with not more than 5 percent total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3 percent in any single harmonic, and no third order harmonics or their multiples. Telephone influence factor: Less than 40.
   e. Engine manufacturer certifies the generator set to be suitable for use at the installed location and rating and meet applicable exhaust emission requirements at the time of commissioning.

9. Mounting:
    a. Provide the engine and generator equipped with a common steel weldment subbase for mounting the engine generator unit to a concrete foundation.
    b. Provide the engine equipped with pad type vibration isolators between the subbase and the concrete foundation.
    c. Install per stamped installation drawings by structural engineer for compliance with IBC seismic bracing requirements.
    d. Isolators (Spring Type): Install isolators between the generator set base and the mounting surface. Provide isolators bolted to the base with a waffled or ribbed pad on their bottom surface. Pads resistant to heat and age, impervious to oil, water, antifreeze, diesel fuel and cleaning compounds.
    e. Isolators (Pad Type): Ribbed or waffled pad. Pads resistant to heat and age, impervious to oil, water, antifreeze, diesel fuel and cleaning compounds.

2.05 GENERATOR CONTROL PANEL

A. Generator Set Control: Provide the generator set with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. Design the control system also to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.

B. Mount the control on the generator set, or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available. Provide control that is vibration isolated and prototype tested to verify the durability of components in the system under the vibration conditions encountered.

C. Generator set mounted control to include the following features and functions:
    1. Control Switches:
        a. Mode Select Switch: The mode select switch to initiate the following control modes. When in the RUN or MANUAL position the generator set to start, and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF position the generator set to immediately stop, bypassing time delays. In the AUTO position the generator set to be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
        b. EMERGENCY STOP Switch: Red "mushroom-head" pushbutton. Depressing the emergency stop switch to cause the generator set to immediately shut down, and be locked out from automatic restarting.
        c. RESET Switch: Use the RESET switch to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
        d. PANEL LAMP Test Switch: Depressing the panel lamp switch to cause the entire panel to be lighted.

D. Generator Set AC Output Metering: Provide the generator set with a metering set including the following features and functions:
    1. Digital metering set, 1 percent accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage to be available in line-to-line and line-to-neutral voltages and display 3-phase voltages (line to neutral or line to line) simultaneously.
    2. Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (KW) meter. Voltmeter and ammeter to display all three phases. Color code meter scales in the following fashion: Green indicates normal operating condition, amber indicates operation in ranges that indicate potential failure, and red indicates failure impending. Metering Accuracy: Within 1 percent at rated output. Both analog and digital metering are required.
    3. The control system to monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110 percent of rated load, in 10 percent increments. Control to display hours of operation at less than 30 percent load and total hours of operation at more than 90 percent of rated load. Control system to log total number of operating hours, total kWH, and total control on hours, as well as total values since reset.

4. Generator Set Alarm and Status Display:
   a. Generator set control to include LED alarm and status indication lamps. Lamps to be high-intensity LED type. Lamp condition to be clearly apparent under bright room lighting conditions.
   b. Generator set control to indicate the existence of the warning and shutdownconditions on the control panel and comply with protection and diagnostic requirements of NFPA 110 for a Level 1 EPSS. Conditions indicated below for warning field-configurable for shutdown. Conditions required to be annunciated to include:
      1) Control switch not in auto (warning)
      2) Emergency stop depressed (warning)
      3) Battery charger AC failure (warning)
      4) Low oil pressure (warning)
      5) Low oil pressure (shutdown)
      6) Low coolant temperature (warning)
      7) High coolant temperature (warning)
      8) High coolant temperature (shutdown)
      9) High oil temperature (warning)
      10) Low coolant level (warning)
      11) Fail to start/overcrank (shutdown)
      12) Overspeed (shutdown)
      13) Low DC voltage (warning)
      14) High DC voltage (warning)
      15) Low fuel level (warning)
      16) High AC voltage (shutdown)
      17) Low AC voltage (shutdown)
      18) Under frequency (shutdown)
      19) Overcurrent (warning)
      20) Overcurrent (shutdown)
      21) Short circuit (shutdown)
      22) Generator powering load
   c. Ground fault (warning)
5. Engine Status Monitoring: The following information to be available from a digital status panel on the generator set control:
   a. Engine oil pressure (PSI or kPA)
   b. Engine coolant temperature (degrees F or C)
   c. Engine oil temperature (degrees F or C)
   d. Engine speed (rpm)
   e. Number of hours of operation (hours)
   f. Battery voltage (DC volts)
6. Engine Control Functions:
   a. The control system provided to include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Provide initial settings for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
   b. Control system to include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system disabled.
   c. Control system to include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control to include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
7. Control Interfaces for Remote Monitoring:
   a. Control system to provide four programmable output relays. Provide relay outputs configurable for any alarm, shutdown, or status condition monitored by the control. Configure the relays to indicate: (1) generator set operating at rated voltage and frequency, (2) common warning, (3) common shutdown, (4) load shed command.

b. Provide the control with a direct serial communication link for the LonWorks communication network interface as described elsewhere in this specification and shown on the drawings.

8. Remote Alarm Annunciator:
   a. Provide and install LED type remote alarm annunciator with horn, located as shown on the drawings or in a location that can be conveniently monitored by facility personnel. Remote annunciator to provide the audible and visual alarms called for by NFPA Standard 110 for level 1 systems for the local generator control panel. Provide spare lamps to allow future addition of other alarm and status functions to the annunciator. Provide provisions for labeling of the annunciator in a fashion consistent with the specified functions. Provide alarm silence and lamp test switch(es). Provide replaceable LED lamps, and indicating lamp color capable of changes needed for specific application requirements. Provide alarm horn switchable for annunciation points. Alarm horn (when switched on) to sound for first fault, and subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA 110. The interconnecting wiring between the annunciator and other system components to be monitored and failure of the interconnection between components displayed on the annunciator panel.
   b. Annunciator to include the following alarm labels, audible annunciation features, and lamp colors:

Condition	Lamp Color	Audible Alarm
Genset Supplying Load	Amber	No
Not in Auto	Red	Yes
High Battery Voltage	Red	Yes
Low Battery Voltage	Red	Yes
Charger AC Failure	Red	Yes
Fail to Start/Overcrank	Red	Yes
Low Engine Temperature	Amber	Yes
Pre-High Engine Temperature	Amber	Yes
High Engine Temperature	Red	Yes
Pre-Low Oil Pressure	Amber	Yes
Low Oil Pressure	Red	Yes
Overspeed	Red	Yes
Low Coolant Level	Amber	Yes
Low Fuel Level	Amber	Yes
Genset Shutdown	Red	Yes
Four Spares	Configurable	Configurable

   c. Provide low battery voltage lamp lighted for low cranking voltage or weak battery alarm.
   d. Provide surface-mounted enclosure.

9. Provide the generator set with a mounted main line circuit breaker, sized to carry the rated output current of the generator set. Circuit breaker to incorporate an electronic trip unit that operates to protect the alternator under overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. Supplier to submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided. Provide auxiliary contact to report to remote annunciator panel in the event of an open breaker condition.

2.06 TRANSFER SWITCH

A. Provide transfer switch, 3 pole moving pole, rated 600 volt, and UL 1008 listed. The transfer switch is suitable for use on types of loads without derating, either open or enclosed. Accessories and equipment are front accessible for ease of maintenance or removal. See drawings for amperage ratings.

B. Switch is inherently double throw and mechanically interlocked to ensure only one of two power positions, normal or emergency.

C. Contact structure to consist of main current carrying contact, silver alloy with minimum 50% silver content. Current carrying contacts protected by silver tungsten arching contacts on sizes above 400 amps.

D. Accessories: Equip each switch with the following accessories and controls:
   1. Time delay engine start (0.5 to 30 seconds).
   2. Time delay, normal to emergency (1 to 60 seconds).
   3. Adjustable time delay in neutral position. Load not connected to utility or generator.
   4. Time delay, emergency to normal (0.2 to 30 minutes) with 5 minutes unloaded. Running for engine cool down cycle.
   5. Test switch to simulate normal power failure.
   6. Engine starting contact.
   7. Two pilot lights to indicate transfer switch position.
   8. Two sets of normally open and normally closed contacts.
   9. Provide voltage sensors to monitor ungrounded lines of the normal source of power. Manual Bypass Equipment: Provide a manual operator capable of transferring power source utilizing the contacts in the switch. Provide written instructions fastened to structure in a plastic diffuser frame for operation of switch in manual mode and test.
   10. NEMA 1 enclosure.

E. Provide transfer switch rated for available fault with upstream overcurrent protection. Provide fused disconnect on utility side of transfer switch as part of Contract to meet manufacturer requirement that transfer switch is protected for available fault current.

F. Configure switch to automatically exercise generator as directed by Owner.

G. Provide required control wiring and heater wiring between generator and transfer switch location.

2.07 WEATHERPROOF ENCLOSURE

A. Outdoor Weather Protective Housing: Factory assembled to generator set base and radiator cowling. Provide ample airflow for generator set operation. Provide hinged side-access doors and rear control door. Provide lockable doors. Standard color sheet metal.

B. Doors give full access to engine, generator control and termination area. Doors have padlock provisions, with integral braces for locking full open during servicing.

C. Provide louvered (rainproof) operation with doors locked closed and engine fully operational at maximum ambient temperature.

D. Steel is 14 gauge minimum for panels.

E. Anchor provisions to secure enclosure to concrete pad are integral to enclosure structure. Space for water drainage under enclosure wall/door panel areas is designed into enclosures.

F. Provide the following factory supplied and installed items within the enclosure, including mounting brackets:
   1. Battery charger.
   2. DC fluorescent lighting run off generator battery and controlled by timer switch.
   3. Disconnect switches for heaters.
   4. Servicing receptacle (weatherproof FS series box).
   5. Disconnect switches of heaters.
   6. Mounting for contactors and relays [and generator stator winding heater].

7. Silencer and exhaust flange.

G. Sheet metal primed for corrosion protection and finish painted with the manufacturers standard color using a two step electrocoating paint process, or equal meeting the performance requirements specified below. Prime and paint surfaces of metal parts. Painting process to result in a coating that meets the following requirements:
   1. Impact resistance, per ASTM D2794, 120-inch-pounds.
   2. Salt Spray, per ASTM B117, 1000+ hours.
   3. Humidity, per ASTM D2247, 1000+ hours.
   4. Water Soak, per ASTM D2247, 1000+ hours.

H. Provide the generator set with a sound-attenuated housing which allows the generator set to operate at full rated load in an ambient temperature of up to 100 degrees F. Enclosure to reduce the sound level of the generator set while operating at full rated load to a maximum of 85 dBA at any location 7 meters from the generator set in a free field environment. Insulate the enclosure with non-hydroscopic materials.

I. Provide an external emergency stop switch that is protected from accidental actuation.

J. Inlet ducts to include rain hoods.

K. Provide a factory mounted and wired electrical distribution panel to serve the generator set and enclosure. The provisions required include:
   1. 100-amp distribution panelboard connected to a 120/240VAC utility service by the installer.
   2. Two duplex GFI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure.
   3. Factory-wired normal AC service from the panelboard to the engine coolant and alternator heaters, and battery charger.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Engine generator unit, coordinate with generator concrete slab pour (or mounting foundation), mounting requirements to eliminate vibration movement, per manufacturer's specifications.

B. Verify piping requirements for natural gas fuel to engine.

C. Provide wiring within transfer switches in accordance to NFPA-76A and NEC requirements.

D. Install and connect the automatic transfer switches components of essential electrical system so that within 10 seconds of a power supply drop in the Utility Company's normal service, the generator starts and automatically transfer loads to the generator source.

E. Installation is in accordance with local, state and federal codes. Verify code requirements as associated with engine generator, transfer switch, fuel storage and transfer prior to installation.

F. Concrete Pad: Provide concrete pad of 2500 to 3000 PSI concrete reinforced with 8 gauge wire fabric or No. 6 reinforcing bars on 12 inch centers. Provide 10-inch thick base of gravel below pad for support. Extend pad 6 inches on all sides from the exterior unit dimensions. Provide pad 8-inches thick with 3/4 inch by 10 foot ground rods at each corner. Thermally bond No. 2 bare copper to rods, reinforcement, and generator ground point.

3.02 TESTING

A. Before the equipment is installed, submit to Architect a factory certified test log of the generator set, showing a minimum one hour test with the generator run continuously at full load at 0.8 power factor. Provide normal preliminary engine and generator tests before unit assembly.

B. Following installation, perform the following tests by the system manufacturer's local dealer representative(s) in the presence of the authority having jurisdiction, as well as owner's engineer or designated appointee:
   1. Pre-Start Checks
   2. Oil level
   3. Water level
   4. Day tank fuel level

5. Battery connection and charge condition
6. Air start supply pressure (if so equipped)
7. Engine to control interconnects
8. Engine generator intake/exhaust obstructions
9. Engine room ventilation obstructions
10. Removal of packing materials
11. Transfer switch settings in compliance with NFPA 110 and owner direction.

C. Operation:
1. Provide functional load testing using the existing building load with run times in accordance with the recommendation of the generator set manufacturer, incorporating transfer switches into the system test. Comply with installation acceptance requirements for Level 1 or 2 Emergency Power Supply System (EPSS) under Chapter 7 of NFPA 110.
2. Before the equipment is installed, submit to Architect a factory certified test log of the generator set, showing a minimum of 4 hour testing with at least 1 hour at 50 percent, 75 percent and 2 hours at 100 percent rated load, continuously. Provide normal preliminary engine and generator tests before unit assembly.
3. Incorporate the transfer switches into final system test.
4. As part of this Contract, provide corrective measures as necessary to comply with specified performance requirements, NEC and local codes.

D. Prior to acceptance of the installation subject the equipment to full load test, using a load bank, for a period of 2 hours, then immediately subject it to building load, for a period of 3 hours. Correct defects which become evident during this test. The engine generator set manufacturer's representative conducts these tests. Supply fuel for test.

E. Include the complete emergency system, consisting of generator, emergency distribution equipment and automatic transfer switches in final test operations. Top off fuel tank at end of test.

3.03 PARTS AND SERVICE

A. The engine generator set supplier is an authorized dealer of the engine generator set manufacturer and is fully qualified and authorized to provide service and parts for both engine generator and such auxiliary equipment as may be required, published operating instructions or periodic maintenance.

B. Provide manufacturer's warranty of 2 years term, based on date of occupancy of the facility.

END OF SECTION

SECTION 26 3600
TRANSFER SWITCHES

PART 1 - GENERAL

1.01 SUMMARY

A. Work included: Materials, installation and testing of:
   1. Transfer Switch
   2. Delayed Transition Transfer Switches
   3. Bypass Isolation Switches
   4. Microprocessor Controller
   5. Accessories
   6. Automatic Sequence of Operation

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical, and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. UL 1008, Automatic Transfer Switches.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements

B. In addition, provide:
   1. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.
   2. Operation Data: Instructions for operating equipment under emergency conditions when engine generator is running.
   3. Maintenance Data: Routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved manufacturers listed below are allowed on condition of meeting the specified conditions including available space allocated for the equipment (including code required working clearances) and functionality of system as described in drawings and specifications. Remove and replace electrical equipment installed and not meeting these conditions at no cost to Owner.
   1. ASCO Power Technologies
   2. Caterpillar
   3. Cummins
   4. Eaton Electrical
   5. Russelectric
   6. Or approved equivalent.

B. Basis of Design: Generator on Drawings is designed based on Asco product line. Approved manufacturers listed below are allowed on condition of meeting specified conditions including available space for equipment (including Code required working clearances). Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.02 TRANSFER SWITCH

A. Provide type, number of poles, amperage, voltage, withstand, and close-on ratings as indicated on Drawings.

B. Provide transfer switch rated for available fault with upstream overcurrent protection.

C. Transfer switches to be 3 cycle rated.

D. Provide NEMA Type 1 - Indoor enclosure.

E. Transfer switch electrically operated and mechanically held. Electrical operator momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears not acceptable. Switch mechanically interlocked to ensure only two possible positions, normal or emergency.

F. Transfer switch sizes use only one type of main operator for ease of maintenance and commonality of parts.

G. Lugs to be mechanical or tool applied compression type.

H. Be positively locked and unaffected by momentary outages, so that contact pressure is maintained at constant value and contact temperature rise is minimized for maximum reliability and operating life.

I. Contact structure to consist of main current carrying contact, silver alloy with minimum 50 percent silver content. Current carrying contacts protected by silver tungsten arching contacts on sizes above 400 amps.

J. Inspection of contacts to be possible from front of switch without disassembly of operating linkages and without disconnection of power conductors.

K. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

L. Where neutral conductors must be switched as shown on Drawings, transfer switch be provided with fully rated overlapping neutral transfer contacts. Neutrals of normal and emergency power sources be connected together only during transfer and retransfer operation and remain connected together until power source contacts close on source to which transfer is being made. Overlapping neutral contacts not overlap for period greater than 100 milliseconds. Neutral switching contacts which do not overlap are not acceptable.

M. Each transfer switch to have means for overriding automatic controls and forcing manual transfer to either source. Switch for forcing manual operation to be equipped with derangement alarm.

N. Each switch to have time delay in neutral position. Time delay adjustable from 0-5 seconds and be initially set at 2 seconds. Provide means to permit neutral delay transfer switches to be driven to neutral position and held there.

2.03 DELAYED TRANSITION TRANSFER SWITCHES

A. Provide delayed transition as indicated on drawings.

B. Each switch to have time delay in neutral position. Time delay adjustable from 0-5 seconds and be initially set at 2 seconds. Provide means to permit neutral delay transfer switches to be driven to neutral position and held there.

2.04 BYPASS ISOLATION SWITCHES

A. Provide bypass isolation as indicated on drawings.

B. Bypass isolation switch provides to manually permit electrical bypass and isolation of automatic transfer switch. Bypass of load to either normal or emergency power source with complete

isolation of automatic transfer switch be possible regardless of status of automatic transfer switch. Bypass-isolation switch permits proper operation by one person through movement of maximum two handles. Entire system consists of two elements: Automatic transfer switch and bypass-isolation switch furnished completely factory interconnected and tested.

C. Operating speed of bypass-isolation switch contacts be independent of speed of operation of bypass handle.

D. Isolation handle provides three positions: Automatic, Test and Isolate. Test position permits electrical testing of automatic transfer switch without disturbing load. Isolate position to completely isolate transfer switch from both sources and load without actual removal of line or load conductors and allow its removal for inspection and maintenance. Transfer switch be arranged for draw out operation to facilitate its removal. Also, while in Test or Isolate positions, bypass-isolation switch functions as manual transfer switch to allow load transfer to either source of power regardless of position or condition of transfer switch, including condition when transfer switch is removed, and without reconnecting load terminal of transfer switch.

E. Load not be interrupted during bypass-isolation functions. Addition of load-break contacts that cause load interruption is not acceptable. Bypass-isolation switch contacts not be in system current path except during actual bypass operation.

F. Bypass isolation switch furnished with detailed step-by-step operating instruction plate as well as following function diagnostic lights:
   1. Bypass switch in normal position.
   2. Bypass switch in emergency position.

2.05 MICROPROCESSOR CONTROLLER

A. Sensing and logic be provided by single built-in microprocessor for maximum reliability, minimum maintenance, and ability to communicate serially through an optional serial communication module.

B. Single controller provides twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements.
   1. Voltage sensing be true RMS type and be accurate to ± 1 percent of nominal voltage.
   2. Frequency sensing be accurate to ± 0.2 percent.

C. Controller be connected to transfer switch by an interconnecting wiring harness. Harness includes keyed disconnect plug to enable controller to be disconnected from transfer switch for routine maintenance. Sensing and control logic be provided on multi-layer printed circuit boards. Interfacing relays be industrial grade plug-in type with dust covers. Panel be enclosed with protective cover and be mounted separately from transfer switch unit for safety and ease of maintenance. Protective cover includes built-in pocket for storage of operator's manuals.

D. Customer connections be wired to common terminal block to simplify field-wiring connections.

E. Controller Display and Keypad
   1. A four line, 20 character LCD display and keypad be an integral part of controller for viewing available data and setting desired operational parameters. Operational parameters also be available for viewing and limited control through serial communications input port. Following parameters only be adjustable via DIP switches on controller:
      a. Nominal line voltage and frequency
      b. Single or three phase sensing
      c. Operating parameter protection
      d. Transfer operating mode configuration (Open transition, Closed transition, or Delayed transition)
   2. Instructions and controller settings be easily accessible, readable and accomplished without use of codes, calculations, or instruction manuals.
   3. Source status screens be provided for both normal and emergency to pro-vide digital readout of voltage on all 3 phases, frequency, and phase rotation.

2.06 ACCESSORIES

A. New transfer switches be equipped with following time delays. Time delays be adjustable in 1 second increments, except extended parallel time which will be adjustable in 0.01 second increments.
   1. Time Delay - Adjustable 0 to 30 seconds on signal to start.
   2. Time Delay - Adjustable 0 to 30 seconds on transfer to emergency.
   3. Time Delay - Adjustable 0 to 60 minutes on re-transfer to normal after normal source failure.
   4. Time Delay - Adjustable 0 to 60 minutes on re-transfer to normal after a system test.
   5. Time Delay - Adjustable 0 to 60 minutes for unloaded cool down of engine generator.
   6. Time Delay - Adjustable 1 to 5 minute time delay on failure to synchronize normal and emergency sources prior to closed transition transfer.
   7. Time Delay - Adjustable 0.1 to 9.99 second time delay on an extended parallel condition of both power sources during closed transition operation.

B. Voltage and frequency on both normal and emergency sources (as noted below) be continuously monitored, with following pickup, dropout, and trip setting capabilities (values shown as percentage of nominal unless otherwise specified):

Parameter	Sources	Dropout/Trip	Pickup/Reset
Undervoltage	N&E, 3	70 to 98%	85 to 100%
Overvoltage	N&E, 3	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

C. Three position momentary-type test switch be provided for test / automatic / reset modes. Test position will simulate normal source failure. Reset position bypasses time delays on either transfer to emergency or retransfer to normal.

D. SPDT contact, rated 5 amps at 30 VDC, be provided for a low-voltage engine start signal. Start signal prevents dry cranking of engine by requiring generator set to reach proper output, and run for duration of cool down setting, regardless of whether normal source restores before load is transferred.

E. Auxiliary contacts, rated 10 amps, 250 VAC, be provided consisting of two contacts, closed when ATS is connected to normal source and two contacts closed, when ATS is connected to emergency source, two contacts closed when normal source is available, two contacts closed when emergency source is available, two controls closed when bypass-to-normal is closed, two contacts closed when bypass-to-emergency is closed.

F. Provide means to drive ATS to a center/off position upon receipt off a dry contact signal from the load sheet controller.

G. Provide load shed relays as indicated on Drawings.

H. Provide signal to test for transfer switches with elevator loads to prevent interruption of power during elevator operation.

I. LED indicating lights (16 mm industrial grade, type 12) be provided; one to indicate when ATS is connected to normal source (green) and one to indicate when ATS is connected to emergency source (red).

J. LED indicating lights (16 mm industrial grade, type 12) be provided and energized by controller outputs. Lights provide true source availability of normal and emergency sources, as determined by voltage sensing trip and reset settings for each source.

K. Communications Interface - Controller be capable of interfacing, through an optional serial communication module, with network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch

applications be available by transfer switch manufacturer. This software allows monitoring, control and setup of parameters.

L. Data Logging - Controller have ability to log data and to maintain last 99 events, even in event of total power loss. Following events be time and date stamped and maintained in non-volatile memory:
   1. Event Logging
      a. Data and time and reason for transfer normal to emergency.
      b. Data and time and reason for transfer emergency to normal.
      c. Data and time and reason for engine start.
      d. Data and time engine stopped.
      e. Data and time emergency source available.
      f. Data and time emergency source not available.
   2. Statistical Data
      a. Total number of transfers.
      b. Total number of transfers due to source failure.
      c. Total number of days controller is energized.
      d. Total number of hours both normal and emergency sources are available.

M. Communications Module - Full duplex RS485 interface be installed in ATS controller to enable serial communications. Serial communications be capable of direct connect or multi-drop configured network. This module allows seamless integration of existing or new communication transfer devices.

2.07 AUTOMATIC SEQUENCE OF OPERATION

A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.

B. Time Delay To Start Alternate Source Engine Generator: 0 to 10 seconds, adjustable.

C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.

D. Time Delay Before Transfer to Alternate Power Source: 0 to 60 minutes, adjustable.

E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.

F. Time Delay Before Retransfer to Normal Power: 0 to 60 minutes, adjustable; bypass time delay in event of alternate source failure.

G. Time Delay Before Engine Shut Down: 0 to 60 minutes, adjustable, of unloaded operation.

PART 3 - EXECUTION

3.01 TRANSFER SWITCH SETTINGS:

A. Transfer Switches:
   1. Time delay on signal to start: 2 seconds
   2. Time delay on transfer to emergency: 0 seconds
   3. Time delay on retransfer to normal: 10 minutes
   4. Time delay for engine cool down: 15 minutes
   5. Time delay on failure to synchronize: 30 seconds
   6. Time delay on extended parallel: 0.1 seconds.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide housekeeping pads under provisions of Division 03, Concrete and extend 4-inches beyond transfer switch width and depth dimensions. Combine minimum 3-inches, above finished floor. Install plumb and level.

C. Provide engraved plastic nameplates under provisions of Section 26 05 53, Identification for Electrical Systems.

D. Install arc flash labels. See Section 26 05 73, Electrical Distribution System Studies.

3.03 ACCEPTANCE AND INSPECTION

A. Factory test complete ATS to ensure proper operation of individual components and correct overall sequence of operation and to ensure that operating transfer time, voltage, frequency and time delay settings are in compliance with specification requirements.

B. Record the following for each switch:
   1. Time delay on retransfer to normal.
   2. Transfer switch time in neutral position during retransfer to normal for each switch with neutral delay.
   3. Time delay to engine shut down for entire system.

C. If transfer switch feeds UPS system, verify that voltage threshold for transfer switch is set to start generator before UPS would switch to battery power. This is to prevent running UPS on battery power during brownout that doesn't start generator.

D. Prior to acceptance of installation, inspect and test equipment on site by service tech employed and bonded by manufacturer, to show it is free of any defects and placed in service. Service tech provides user training on day of on-site testing.

3.04 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Division 01, General Requirements.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.22.3.

3.05 CLOSEOUT ACTIVITIES

A. Demonstrate operation of transfer switch in bypass, normal, and emergency modes.

3.06 MAINTENANCE

A. See Division 01, General Requirements, for additional requirements relating to maintenance service.

3.07 TESTING

A. Reference Section 26 08 05, Electrical Acceptance Testing.

END OF SECTION

SECTION 26 4300
SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. SPD for Distribution Panels - Nonmodular Type

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Listed per UL 1449, third edition, and complimentary listed per UL 1283 as FRI/EMI filter.
   2. Comply with ANSI/IEEE C62.45 test procedures for Category-C3 established in C62.41.2 and CSA certified (C22.2).

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Related SPD Specifications, Drawings, maintenance manuals, installation instructions, and UL 1449, third edition, listed surge suppression ratings of specified protection modes.
   2. Project Record Documents: Record actual locations of SPDs.
   3. Maintenance Data:
      a. Include module replacement instructions.
      b. Include maintenance and troubleshooting instructions for electronic components.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Manufacturer's Qualifications: ISO 9001 certification SPD manufacturer's complete quality control and documentation procedures of firms regularly engaged in manufacturer's of SPD product for Category-C3 (ANSI/IEEEC62.41.2) and whose product has been of satisfactory service for not less than 5 years.
      a. Provide local support for SPD.
      b. Provide both service entrance and distribution panel SPD of same manufacturer.
   2. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2- PRODUCTS

2.01 MANUFACTURERS

A. Current Technology

B. Eaton Electrical

C. Lea International

D. Liebert

E. Square D

F. Surge Suppression Inc. (SSI)

G. Or approved equivalent.

2.02 SPD FOR DISTRIBUTION PANELS - NONMODULAR TYPE

A. List SPD in accordance with UL 1449 (third edition), Standard for Safety, Surge Protective Devices, and UL 1283, Electromagnetic Interference Filters.

B. Independently test SPD with Category-C3 high exposure waveform (20KV - 1.2/50 µs, 10 kA - 8/20 µs) per ANSI/IEEE C62.41.2 (2002)

C. Provide SPD with copper bus bars for surge current path. Small gauge round wiring, plug-in type connections, or printed circuit boards not be used in path for surge current diversion. Equally distribute surge current to MOV components to ensure equal stressing and maximum performance. Surge suppression platform must provide equal impedance paths to each matched MOV.

D. Use no plug in component modules or printed circuit boards as surge current conductors. Hardwire internal components with connections utilizing low impedance conductors and compression fittings.

E. In order to isolate SPD under any fault condition, manufacturer to provide:
   1. Individually fuse the MOV via copper fuse. Copper fuse provides protection during high (ka) surge events.
   2. Equip MOVs with thermal fuse which allows disconnection of suppression component at overheating stage common during TOV.
   3. Test over-current protection components in compliance with UL 1449 (third edition) -Limited Current Test and AIC rating test.

F. Equip SPD with an audible alarm that activates when one of surge current modules have failed. Provide an alarm on/off switch to silence alarm. Provide an alarm push-to-test switch to test the alarm. Locate switches and alarm on the front cover of the SPD's enclosure.

G. Provide SPD that Meet or Exceed the Following Criteria:
   1. Provide maximum single impulse current rating at no less than 100 kA per phase. Manufacturers must provide documented proof of independent third party verification of single impulse current withstand capabilities.
   2. Pulse Life Test: Capable of protecting against and surviving 2000 ANSI/IEEE C62.41.2 Category-C3 transients without failure or degradation of UL 1449 (third edition) clamp voltage by more than 10 percent.
   3. UL 1449 (third edition) clamping voltage not to exceed the following:

VOLTAGE	L-G	L-N	N-G
208Y/120V	800V	800V	800V

   4. Nominal discharge current of 20KA I (n).

H. Make SPD of solid-state components which operate bidirectionally.

I. Provide SPD with response time no greater than five nanoseconds for individual protection modes.
   1. SPD designed to withstand maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.
   2. Provide visible indication of proper SPD connection and operation. Provide 10 year warranty, incorporating unlimited replacements of SPD if they are destroyed by transients within warranty period.

J. Provide SPD designed to withstand maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.
   1. Provide terminals for necessary power and ground connections.
   2. Provide SPD with minimum EFI/RFI filtering of 30dB at 100KHZ with an insertion loss ratio of 316:1 using Military Standard 220A methodology.

3. Provide SPD with 10 year warranty, incorporating unlimited replacement parts if they are destroyed by transients during warranty period.

PART 3 - EXECUTION

3.01 SERVICE ENTRANCE

A. Install SPD on load side of service entrance as directed by manufacturer's installation instructions. Provide 3 pole breaker for disconnect in service entrance equipment, size breaker to manufacturers installation instructions.

B. Install one primary SPD at each utility service entrance to facility, according to manufacturer's recommendations.

C. Integrate SPD unit into switch gear to maximize performance and reliability.

D. Bond SPD's ground to service entrance ground.

3.02 DISTRIBUTION PANELS

A. Install one secondary SPD at each distribution panel location as indicated on Drawings. SPD unit to be integral to panelboard.

3.03 MAINTENANCE MATERIALS

A. Furnish the following for Owner's use in maintenance of project:
   1. Replacement modules: One of each type and size.

END OF SECTION

SECTION 26 5100
LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Luminaires
   2. Ballasts and Power Supplies
   3. Lamps
   4. Lighting Poles

B. Provide wiring for complete and operating lighting system.

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. NECA 500 - Commercial Lighting

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01 General Requirements.

B. In addition, provide:
   1. Submit:
      a. Luminaires: Include electrical ratings, dimensions, mounting, material, required clearances, terminations, wiring and connection diagrams, photometric data, diffusers, and louvers.
      b. Ballasts and Power Supplies
      c. Lamps
      d. Emergency Lighting Equipment
      e. Lighting Poles
   2. Submittal Cutsheets: Highlight, circle or otherwise graphically indicate which option(s) are being selected for the products submitted. Cutsheets that are not edited to indicate which products and options are submitted for this project or that list only catalog numbers to identify submitted options are not acceptable.
   3. Specified manufacturers are approved to submit bid. However, inclusion does not relieve manufacturer from supplying product as described.
   4. Provide the following operating and maintenance instructions as required by Section 26 00 00, Electrical Basic Requirements:
      a. Luminaires
      b. Ballasts and Power Supplies
      c. Lamps
      d. Emergency Lighting Equipment
      e. Lighting Poles

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Provide luminaires acceptable to code authority for application and location installed.
   2. Comply with applicable ANSI standards.
   3. Comply with applicable NEMA standards.

4. Provide luminaires and lampholders that comply with UL standards and have been listed and labeled for location and use indicated by a testing agency acceptable by the AHJ (e.g. UL, ETL, and the like).
5. Comply with NEC as applicable to installation and construction of luminaires.
6. Comply with fallout and retention requirements of CBC, IBC, or OSSC for diffusers, baffles, and louvers.
7. Provide similar lamps and ballasts from common manufacturer (e.g. all fluorescent lamps from Osram/Sylvania, and all MR lamps from Ushio) unless indicated otherwise in the Luminaire Schedule.

1.06 WARRANTY

A. Warranty as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
1. Warranty: LED systems and complete luminaires must have manufacturer's warranty of a minimum of 5 years from date of substantial completion, including driver.

1.07 ADDITIONAL MATERIAL

A. Furnish 2 percent extra lens or louvers for each size and type of fluorescent luminaire.

B. Furnish 10 percent extra lamps for each size and type installed.

C. Furnish 5 percent extra ballasts for each size and type.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. As specified in Articles below.

B. Or approved equivalent.

2.02 LUMINAIRES

A. Luminaires: Reference description and manufacturers in Luminaire Schedule on drawings.

B. Where recessed luminaires are installed in cavities intended to be insulated, provide IC rated luminaires or other code approved installation.

C. UL label luminaires installed under canopies, roof or open porches, and similar damp or wet locations, as suitable for damp or wet location.

D. Suspended luminaires: Provide minimum 24-inch adjustability in aircraft cable length where used.

E. Recessed Luminaires: Frame compatible with ceiling material installed at particular luminaire location. Provide proper factory trim and frame for luminaire to fit location and ceiling material. Verify with Architectural Reflected Ceiling Plan prior to submittals.

F. Finishes:
1. Manufacturer's standard finish (unless otherwise indicated) over corrosion resistant primer.
2. Interior Light Reflecting Finishes: White or specular finish with not less than 85 percent reflectance.
3. Exterior Finishes: As detailed in luminaire schedule or on drawings. Refer cases of uncertain applicability to Architect for resolution prior to release for fabrication.

G. Light Transmitting Components:
1. Plastic diffusers, molded or extruded of 100 percent virgin acrylic.
2. Prismatic acrylic, extruded, flat diffusers, 0.125-inch overall thickness, unless otherwise noted.

2.03 POWER SUPPLIES

A. General:
1. Provide ballasts UL rated for specified lamps.
2. Thermal Protection: Internal UL Class 'P' with automatic reset.

3. Sound Ratings: Class 'A'. Where not available as standard product from any specified manufacturer, provide quietest rating available.
4. Total Harmonic Distortion: Not to exceed 20 percent of input current unless otherwise indicated.
5. Input Voltage: Provide universal voltage ballast matching branch circuit supply voltage.
6. Provide quantity of ballasts to provide switching as indicated on drawings.
7. Provide factory printed wiring diagram on ballast housing.
8. Type 1 construction for ballasts used in enclosed and gasketed luminaires.
9. Comply with FCC rules and regulations Part 18, Class A concerning generation of both electromagnetic interference and radio frequency interference.

2.04 LAMPS

A. Provide lamps for luminaires.

B. Provide lamp catalogued for specified luminaire type.

C. Manufacturers: Osram Sylvania, General Electric, Philips, Venture, Ushio (MR only), EYE (MR only), or approved equivalent unless specific manufacturer is indicated in Luminaire Schedule.

D. LED (Light Emitting Diode):
   1. LED manufacturer will include, but not be limited to, light source, luminaire, power supply and control interface with added components as needed for complete and functioning system.
      a. Comply with ANSI chromaticity standard for classifications of color temperature. See luminaire schedule for specified LED lamp color and color temperature. UL or ETL listed and labeled.
      b. Luminaire testing per IESNA LM-79 and LM-80 procedures.
      c. Lamp life for white LEDs: 50,000 plus hours with lamp failure occurring when LED produces 70 percent of initial rated lumens.
      d. Lamp life for color LEDs: 30,000 plus hours with lamp failure occurring when LED produces 50 percent of its initial rated lumens.
      e. LED Drivers: reverse polarity protection, open circuit protection, require no minimum load. Minimum 80 percent efficiency. Class A noise rating.
      f. Dimming: LED system capable of full and continuous dimming.
      g. LED light source manufacturers: Nichia, Cree, Osram Sylvania, GE Lumination.
   2. Special types as indicated in luminaire schedule.

2.05 LIGHTING POLES

A. Provide direct buried exterior light poles with concrete bases or direct buried which are structurally supportive of pole under design loading.

B. Provide exterior poles clean and scratch free with base bolt covers to match pole and luminaire finish.

C. Provide poles and pole bases rated for a minimum of 100 MPH, unless otherwise noted. Wind EPA loading for quantity and type of luminaire it supports with a 1.3 gust factor.

D. Provide poles with gasketed handholes, stainless steel tamper resistant hardware, anchor bolts and ground lugs.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install luminaires securely, in neat and workmanlike manner.

B. Install luminaires of types indicated where shown and at indicated heights in accordance with manufacturer's written instructions and with recognized industry practices to ensure that luminaires comply with requirements and serve intended purposes.

C. Align, mount and level luminaires uniformly. Use ball hangers for suspended stem mounted luminaires.

D. Avoid interference with and provide clearance from equipment. Where indicated locations for luminaires conflict with locations for equipment, change locations for luminaire by minimum distance necessary as directed by Architect.

E. Suspended Luminaires: Mounting heights indicate clearances between bottom of luminaire and finished floors.

F. Emergency Egress Luminaires: Provide unswitched circuit for battery charging and autotransfer circuiting for exit signs and luminaires with integral batteries or Provide unswitched emergency circuit to exit signs and emergency luminaires. Where test switch cannot be integral to luminaire, mount remote test switch flush-to-ceiling and adjacent to egress luminaire.

G. Interior Luminaire Supports:
   1. Support Luminaires: Anchor supports to structural slab or to structural members within a partition, or above a suspended ceiling.
   2. Maintain luminaire positions after cleaning and relamping.
   3. Support luminaires without causing ceiling or partition to deflect.
   4. Provide mounting supports for recessed and pendant mounted luminaires as required by IBC.

H. Exterior Luminaire Supports:
   1. Provide concrete bases for pole-mounted lighting units and bollard lights at locations shown on site plan drawing(s). Provide concrete bases as shown on drawings or as recommended by manufacturer if not shown on drawings. Minimum base height above grade in automobile areas is 30-inches. Install luminaire poles plumb.
   2. Install pole concrete bases in undisturbed or compacted soil. Where soil is disturbed provide backfill and compaction per Division 31, Earthwork requirements.

I. Wiring:
   1. Recessed luminaires to be installed using flexible metallic conduit with luminaire conductors spliced to branch circuit conductors in nearby accessible junction box over ceiling. Junction box fastened to building structural member within 6-feet of luminaire.
   2. Luminaires for lift out and removal from ceiling pattern without disconnecting conductors or defacing ceiling materials.
   3. Flexible connections where permitted to exposed luminaires; neat and straight, without excess slack, attached to support device.
   4. Install junction box, flexible conduit and high temperature insulated conductors for through wiring of recessed luminaires.

J. Relamp luminaires which have failed lamps at substantial completion.

K. Replace ballasts deemed as excessively noisy by Architect, Engineer, or Owner.

L. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

M. Support luminaires larger than 2- by 4-foot size independent of ceiling framing.

N. Locate recessed ceiling luminaires as indicated on architectural reflected ceiling plan.

O. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

P. Exposed Grid Ceilings:
   1. Support surface mounted luminaires in grid ceiling directly from building structure.
   2. Provide auxiliary members spanning ceiling grid members to support surface mounted luminaires.
   3. Fasten surface mounted luminaires to ceiling grid members using bolts, screws, rivets, or suitable clips.

Q. Install recessed luminaires to permit removal from below.

R. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

S. Install clips to secure recessed grid-supported luminaires in place.

T. Install wall mounted luminaires, emergency lighting units, and exit signs at height as indicated on Architectural Drawings.

U. Install accessories furnished with each luminaire.

V. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

W. Bond products and metal accessories to branch circuit equipment grounding conductor.

X. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.

Y. Where manufactured wiring assemblies are used, insure that wiring assembly manufacturer sends components to appropriate luminaire manufacturer for respective installation of proper components.

3.02 COORDINATION

A. Coordination of Conditions: Coordinate ceiling construction, recessing depth and other construction details prior to ordering luminaires for shipment. Refer cases of uncertain applicability to Architect for resolution prior to release of luminaires for shipment. Where luminaires supplied do not match ceiling construction, replace luminaires at no cost to Owner.

B. Electrical drawings are schematic, identifying quantity and type of luminaires used and their approximate location, but are not to be used for dimensional purposes. Reference architectural drawings for exact locations, including mounting heights.

C. Provide lighting indicated on drawings with luminaire of the type designated and appropriate for location.

D. Provide fluorescent and HID luminaires with ballast compatible to lighting control system as shown in drawings and as specified.

E. Where remote ballasts and drivers are required, insure adequate accessibility to ballast. Upsize conductors between luminaire and ballast to accommodate voltage drop.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Division 01, General Requirements.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.04 ADJUSTING

A. Aim and adjust luminaires as indicated.

B. Focus and adjust floodlights, spotlights and other adjustable luminaires, with Architect, at such time of day or night as required.

C. Align luminaires that are not straight and parallel/perpendicular to structure.

D. Position exit sign directional arrows as indicated.

3.05 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures.

C. Clean paint splatters, dirt, dust, fingerprints, and debris from luminaires.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damaged finishes per by manufacturer's instructions.

3.06 CLOSEOUT ACTIVITIES

A. Demonstrate luminaire operation for minimum of two hours.

END OF SECTION

SECTION 27 0000
COMMUNICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Division 27 – Communications governs the infrastructure for the low-voltage information transport systems, which include voice and data and their pathways.

B. Description of Work:

1. Furnish and install materials for the communications infrastructure systems as specified herein and as shown on the drawings. Upon completion, the systems shall be functioning in compliance with performance requirements specified.

2. The cabling specified and shown on the drawings is for complete, performance based, workable systems. Deviations from the cabling shown due to a particular manufacturer's requirements shall be made only with the written approval of the Architect and the Owner, and at no additional cost to the Owner.

3. This division also includes telecommunications cabling, connections, and equipment needed for the A/V projection and sound reinforcement and IP Video Camera cabling. Refer to “T” series drawings for locations, quantities and additional requirements.

1.02 SECTION INCLUDES

A. Definitions

B. Quality Assurance

C. Submittal Requirements

1.05 DEFINITIONS

A. Advanced System Warranty – an extended warranty held either by the connectivity or cabling manufacturer directly with the Owner for this project that guarantees product and performance of the entire cabling system for the warranty period.

B. Conveniently Accessible - being capable of being reached from floor or use of 8’ step ladder without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

C. Entrance Room – A space in which the joining of campus and building telecommunications backbone facilities takes place.

D. Equipment Room – An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate crossconnect, as well as video surveillance and security equipment.

E. IDF – Intermediate Distribution Frame, also known as a Telecommunications Room (TR) or Communications Room.

F. Lead Telecommunications Installer –the project manager for the Telecommunications Subcontractor for all telecommunications work in the construction documents (T-series drawings and specification Section 27), who shall be on-site at all times while Division 27 work is being performed. This individual shall attend all construction project meetings.

G. Listed Communications Cable – A cable listed by the Underwriters Laboratory (UL®) and accepted by the local authority having jurisdiction as having met appropriate designated standards or has been tested and found suitable for installation in specific spaces. Refer to *NEC*® Section 800 for listing types and additional requirements.

H. MDF – Main Distribution Frame, also known as the Main Equipment Room.

I. Plenum – A compartment or chamber to which one or more air ducts is connected and that forms part of the air distribution system. Assume space above suspended/accessible ceilings is a plenum.

J. Plenum-rated – listed by the Underwriters Laboratory as being suitable for installation into a plenum space. Communications cabling routed through plenum-rated space shall be plenum-rated and identified as Type CMP.

K. Point of Entrance (Building Entrance) - The point within a building at which the Outside Plant (OSP) communications wire or cable emerges from an external wall, from a concrete floor slab, or from a rigid metal conduit (Type RMC) or an intermediate metal conduit (Type IMC) connected by a grounding conductor to an electrode in accordance with the *NEC*®.

L. Subcontractor, Telecommunications – company responsible for all telecommunications work in the construction documents (T-series drawings and specification sections 27 0000 through 27 5319).

M. Telecommunications – in general, telecommunications refers to infrastructure/equipment needed for the voice, data, and video communications and transport systems. N. Telecommunications Consultant – As defined for sections referring to telecommunications work only, this Consultant shall be the telecommunications design consultant employed by the Owner for the purpose of observing the work of the Communications Subcontractor(s).

O. Telecommunications Room - An environmentally enclosed architectural space designed to contain telecommunications equipment, cable terminations, or crossconnect cabling. The Main Equipment Room may also be known as the MDF, and may be co-located with the building's Entrance Room and Equipment Room. Telecommunications Rooms will also house equipment for additional systems, such as security, cable television, and audio/video.

P. UL® – Underwriters Laboratory

1.06 QUALITY ASSURANCE

A. Telecommunications Subcontractor Qualifications

1. Company Requirements

a) The Telecommunications Subcontractor shall have total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications.

b) Telecommunications Systems specified shall be assembled and installed under the direction of a qualified Telecommunications Subcontractor.
Qualification requirements shall include submittal by the Telecommunications Subcontractor to the Architect of the following:

1) List of previous projects of this scope and nature, including names and sizes of projects (to include square footage and construction cost – overall and that of the Telecommunications Subcontractor), description of work, times of completion, and names of contact persons for reference.

2) Installers shall certify that they are manufacturer-authorized or trained for work to be performed.

2. Lead Telecommunications Installer Requirements:

a) Lead Communications Installer shall be a current member of BICSI in good standing and have completed (at a minimum) BICSI ITS Installer 2 Training (for both copper and fiber).

b) Submit certificate of ITS Installer 2 Training (or higher) with bid and preconstruction submittal package.

c) Advanced training from connectivity manufacturer may be submitted in lieu of BICSI ITS Installer 2 Training. Submit manufacturer training certificates for review by Owner as substitution request as part of Pre-Bid questions. This training must be by the same manufacturer that will hold the Advanced System Warranty.

3. General Telecommunications Installer Requirements:

a) For all work associated with Specification Sections 27 all installers are to have a minimum of BICSI ITS Installer 1 Training or equivalent training from the connectivity manufacturer.

b) Submit a list with bid of names of all installers and appropriate copies of certificates verifying training with pre-construction submittal package.

C. Warranty Requirements

1. Project Warranty

a) Equipment and materials required for installation under these specifications shall be the current model and new (less than one year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect.

b) When a defect or problem is observed within the first year after substantial completion, the Owner will notify the governing subcontractor through the proper channels. The appropriate Subcontractor then has 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or Owner.

2. Advanced System Warranty for Telecommunications (Copper and Fiber Systems)

a) Beyond the initial one year project warranty, the Telecommunications Systems shall be warranted for a minimum of 20 years by a national and reputable connectivity or cabling manufacturer.

1) This warranty shall cover any material defect, as well as the performance of the cabling system. (Example: A Category 6A cabling system is to deliver 10,000BASE-T speed, or 10 “Gig” performance for the entire length of the warranty period.)

2) This warranty shall cover both material and labor for the full length of the warranty period.

b) The Telecommunications Subcontract shall be certified by this manufacturer.

c) The following manufacturers are conditionally approved to provide the system warranties (subject to specific project requirements):

1) Copper Connectivity Manufacturers

i. CommScope

ii. Panduit

2) Fiber Connectivity Manufacturers

i. CommScope

ii. Panduit

3) Cabling Manufacturers

1 CommScope

I. General (for Panduit product Set)

D. When articles, materials, operations or methods related to execution of communications work are noted, specified, or described in the specifications or are indicated or reasonably implied on drawings and schedules, execute work as required or appropriate to provide complete and proper function, operation and installation.

E. The drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Telecommunications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the Telecommunications Consultant.

F. The drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility; they do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Telecommunications Subcontractor.

G. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

1.07 SUBMITTALS

A. General Requirements

1. Provide Submittals in accordance with Section 01 3300
2. Architect shall receive and Telecommunications Consultant is to review all submittals related to Division 27 work. This includes, but is not limited to, relevant:
   a) Pre-bid questions,
   b) Contractor and personnel qualifications with bid,
   c) Voluntary alternates and unit pricings with bid,
   d) Pre-construction product submittals and shop drawings,
   e) Change order requests, requests for information (RFIs), design change directives (DCDs), and any other changes as directed by the architect/engineer.
3. Record drawings and warranty certificates/letters shall be in accordance with Section 01 7839.
4. Allow a minimum of one week (five working days) for the Telecommunications Consultant to review.

B. The following submittals are due at the Pre-Bid deadline for questions:

1. Requests for product substitution shall be in accordance with Section 01 6000
   a) All products seeking approval either as “approved equivalent” or otherwise, shall be submitted as a product substitution request prior to bid. Failure to submit product substitution request in a timely manner (before pre-bid questions are due) may preclude product from being utilized on the project. Requests made with bid or post-bid will not be considered without a significant cost savings realized to the Owner.

b) The burden of proof is on the contractor to provide documentation that equivalent product meets the specifications and project requirements. Include in substitution request:

1) Product being replaced

2) Reason for product substitution

3) Full manufacturer specification sheet clearly indicating that all requirements in project documents have been met

c) Failure to meet these requirements will result in the product substitution request being returned without review.

d) All product substitution requests are to be reviewed and approved by the Telecommunications Consultant. Not all requests will be approved, and all decisions are final, without recourse. C. The following submittals are due with the Bid:

1. Proof of Telecommunications Subcontractor and personnel qualifications

a) Provide a typed list with the following information:

1) Company name of Telecommunications Subcontractor

2) List of connectivity or cabling manufacturers that the Telecommunications Subcontractor is certified to install and provide advanced warranty for.

3) List of previous projects (minimum of 3) of this scope and nature, including:

I. Project name and date of completion

II. Project size (square feet of building, total construction cost, total cost of telecommunications scope)

III. Name and contact information for building owner or IT Manager

4) Name and contact information for Lead Telecommunications Installer

b) Provide certificates or letter(s) from BICSI and / or manufacturers verifying by name these qualifications have been met.

c) Refer to Quality Assurance subsection in this specification section for additional requirements and qualifications.

2. Voluntary alternatives (that realize substantial cost savings)

3. Unit pricing for the following items:

a) All unit pricing relating to Division 27 as identified in Section 01 2200.

D. The following submittals are due at the Pre-Construction Phase (to be delivered to the Project Architect with copies to Telecommunications Consultant):

1. General Requirements:

a) Follow submission guidelines as outlined in Division 1. At a minimum, provide the requirements as outlined in this section. Where Division 1 requirements are more stringent, follow those in addition to the requirements in this section.

1) Strictly electronic submission to Telecommunications Consultant is acceptable. General contractor, architect, and engineering requirements may differ.

b) Ensure a cover page with Project Title, Telecommunication Subcontractor Company, and point of contact is included for all physical submittals.

c) Updated Personnel Qualifications

1) Provide a list of names of all telecommunications installers with appropriate certificates from BICSI or the manufacturer.

2. Product Information, divided by Specification Section and in order as listed in specification. Identify the start of each specification section.

a) Provide manufacturer's product information cutsheet or specifications sheet with the specific product number identified or filled out.

1) Submitted cutsheets without specific product identified will result in the whole submittal being returned without review.

2) No product substitutions will be considered post bid without a significant cost savings to the project to be realized by the owner – a minimum of $1000, either in material or labor savings. For any product substitution requests post-bid, Telecommunications Subcontractor shall submit an RFI through the proper channels with the requested documentation from the Pre-bid requirements above. Also, include realized cost savings. The project team may issue a change order (or its equivalent) for the product change at their discretion.

I. One exception to this is if the specified product goes out of production and is unavailable before submitted shop drawings are approved. Telecommunications or Subcontractor is to submit an RFI explaining the situation and recommending an equivalent product with the same features at no cost change to the project or Owner.

II. Other exceptions may be considered. Telecommunications Subcontractor is to submit an RFI explaining the situation.

3. Shop Drawings

a) Conform to all requirements of Section 01 3300. In n addition, generate electronic shop drawings in AutoCAD®, dwg file format, version 2004 (or newer), saved to disk (CD-R or DVD+/-R) or USB Flash Drive with project name and number clearly indicated [or uploaded to project website]. Shop drawings shall include Telecommunications or Subcontractor title block and included readily printable Plot/Drawing tabs with mview-window at a scale to not be less than 1/8"=1'-0" unless otherwise noted. The scale shall also be indicated on the drawings.

1) Acceptable electronic shop drawing sizes include: 8.5"x11", 11"x17", 22"x34" or 24"x36".

b) Refer to individual sections for additional requirements.

c) Communications pathways

1) Hangers and Supports – indicate proposed routing of all cabling supported by J-hooks.

2) Cable Trays - indicate size and proposed routing of all communications cable trays; should any of those locations or

sizes differ from the construction drawings due to minor coordination issues, cloud the affected area and note why the change is necessary. (For major coordination issues, please submit an RFI.)

3) Firestopping – indicate manufacturer, product/assembly, and UL system for all firestop penetrations required for communications cabling.

E. The following submittals are due during Construction (project closeout), in accordance with the requirements in Sections 01 7839 and 27 0000 - Communications:

1. 3 weeks prior to Substantial Completion:

a) Record Drawings

1) Modify reviewed and accepted AutoCAD® shop drawings to include revisions based upon completion of work.

2) Provide (1) printed set of record drawings to scale (not less than 1/8" = 1'-0").

3) This set is to include system function diagrams and details not on original construction documents.

b) Test Results, in accordance with section 27 0800.

c) With the exception of the (1) printed set of record drawings, submit these files electronically either on disk (CD or DVD) or USB Flash Drive, with project name and number clearly indicated.

2. Within two weeks after Substantial Completion:

a) Warranty Certificates for the Advanced Telecommunications System Warranty for the copper and fiber systems with point of contact for any warranty claims.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

B. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer and part number.

C. All products and materials shall be new and unused prior to their installation as part of this project. Refurbished items are not allowed.

PART 3 - EXECUTION

3.01 GENERAL

A. Coordinate with all other trades prior to installation.

1. Telecommunications Subcontractor shall meet with Electrical, Mechanical, and General Contractors prior to construction to identify pathway and infrastructure space requirements.

a) At a minimum, the following items shall be discussed:

1) Cable tray locations and clearance space above (12" if possible, with proper coordination)

2) Placement for sleeving and wall penetrations

3) In-ceiling projection screens and other audio/video equipment.

b) Failure to coordinate sufficient space for telecommunications infrastructure shall result in relocation of various systems by the contractor at no additional cost to owner.

2. Prior to the start of work, the Telecommunications Subcontractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where Division 27 work may properly commence. Start of work indicates acceptance of conditions.

3. Coordinate location of equipment and conduit with other trades to minimize interference.

a) Holes through concrete and masonry structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the General Contractor as required by limited working space.

b) Holes shall be located so as not to affect structural sections such as ribs or beams.

c) Holes shall be laid out in advance. The General Contractor shall be advised prior to drilling through structural sections, for determination of proper layout.

d) Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors, provide an effective barrier against the spread of fire, smoke and gases.

B. Follow all manufacturers' instructions and install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.

1. In the event of discrepancy, immediately notify the Telecommunications Consultant through the proper channels. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

C. Protection of Systems and Equipment

1. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.

2. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.

3. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum-cleaned both inside (as appropriate) and outside before testing, operating or painting.

4. As determined by the Telecommunications Consultant, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Telecommunications Consultant shall be final.

5. Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.

6. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.

D. Access to Equipment

1. Equipment shall be installed as per the scaled detail on the T-series Drawings. .
2. Working spaces shall be not less than specified in the National Electrical Code® for voltages specified.
3. Where the Telecommunications Consultant determines that the Telecommunications Subcontractor has installed equipment not “conveniently accessible” for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Telecommunications Consultant, at no additional cost to the Owner.

E. Cleaning

1. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.
2. Remove dust and debris from interiors and exteriors of telecommunications equipment (including electrical rough-in). Clean accessible current carrying elements prior to being energized.

F. Completion

1. General:
   a) Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.
2. Results Expected:
   a) Systems shall be complete and operational. Cleaning

   work shall be complete.
3. Testing and Verification – General Requirements
   a) Refer to individual sections for additional testing and verification requirements.
   b) The Telecommunications Subcontractor shall verify that requirements of this specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.
   c) Verification by Inspection: Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the specifications.
   d) Verification by Test and Demonstration: The Telecommunications Subcontractor shall verify by formal demonstrations or tests that the requirements of this Specification have been met. The Communications Subcontractor shall demonstrate that the communications systems components and subsystems meet specification requirements in the "asinstalled" operating environment during the "System Operation Test".
   e) Perform system operation tests after full enclosure of walls.
   f) System Operation Tests Conducted Upon Completion of Work: Upon completion of the Telecommunications Subcontractor's Work, subject the

system to functional and operational tests. When required corrections determined by initial test results have been completed, fully retest the system. The Owner shall be notified in writing not less than seven days in advance of date of proposed final testing and inspection. The advance notice shall include certification that the installation is complete and operable and that the Telecommunications Subcontractor has satisfactorily performed the final tests specified herein. The acceptance testing and final inspection shall be accomplished in the presence of the Owner and the Telecommunications Consultant. At least 10 days prior to scheduled system completion, the Telecommunications Subcontractor shall submit, for approval by Owner and Telecommunications Consultant, a test plan to completely test the telecommunications system. The Telecommunications Subcontractor shall include in test plan, for acceptance by the Owner and Telecommunications Consultant, a complete and detailed final acceptance test check-off list ("punch list"). The list shall be a complete representation of specified functions and conditions.

4. Commissioning

a) There shall be three phases of commissioning:

1) Rough-in inspection

2) Above-ceiling inspection (after cables are placed)

3) Final inspection

b) At a minimum, the Telecommunications Consultant shall check the following items:

1) Accurate location and height above finished floor for all outlet boxes.

2) Accurate dimensions (particularly depth) of all outlet boxes and diameter of in-wall conduit serving outlet boxes.

3) Cable tray size, location, and clearance.

4) Location and size of all other communications conduits or pathways

5) That power receptacles within the communications rooms meet the design requirements.

6) The Telecommunications Consultant is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate subcontractor(s) and all items are to be addressed.

This report is not necessarily all inclusive; should issues be discovered later in the project, the appropriate communications subcontractor is still responsible for corrections/repairs.

c) Once all communication cabling has been installed and properly supported and walls have been painted, but prior to the installation of ceiling tiles/material, the Telecommunications Consultant shall schedule a time to be on-site to conduct above-ceiling inspection.

1) At a minimum, the Telecommunications Consultant shall check the following items:

i. That all items from the previous inspection have been corrected.

ii. That communications cabling is routed correctly and adequately supported.

iii. That communications cabling is not painted or over sprayed.

iv. That the installed communications cabling matches what was specified / submitted.

v. That there are no kinks, splices, or other damage to the installed communications cabling.

2) The Telecommunications Consultant is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate subcontractor(s) and all items are to be addressed. This report is not necessarily all inclusive; should issues be discovered later in the project, the appropriate communications subcontractor is still responsible for corrections/repairs.

d) Once all communications work has been completed, contractor shall request final inspection. This request shall be made 3 weeks before substantial completion. The Telecommunications Consultant shall then schedule a time to be on-site to conduct this inspection; the Telecommunications Consultant shall also invite the Owner to attend this inspection.

1) At a minimum, the Telecommunications Consultant shall check the following items:

I. That all items from the previous inspections have been corrected

II. That all faceplates are installed, with the correct modules, quantity of modules, and approved labeling scheme

III. That all equipment and cabling within communications rooms is installed per the contract documents, including all patch panels and wall blocks (with specified spare capacity), horizontal and backbone cabling labeling, and telecommunications grounding.

IV. And all other items necessary to guarantee contract documents are met and complete and functioning communications systems are installed.

2) The Telecommunications Consultant is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate subcontractor(s) and all items are to be addressed prior to substantial completion. This report is not necessarily all-inclusive; should issues be discovered within one year after substantial completion, the appropriate communications subcontractor is still responsible for corrections/repairs.

END OF SECTION

SECTION 27 0126

SUBMITTALS AND SHOP DRAWINGS

PART 1 GENERAL

1.01 REQUIREMENTS

A. Refer to General Divisions for submittal requirements and procedures.

1.02 DEFINITIONS

A. Manufacturer's Product Data: Manufacturer's product data consist of one or more levels of manufacturer's information as described below and as requested in the submittal schedule. The three levels of information include: manufacturer's list, manufacturer's catalog data, and manufacturer's technical and engineering data.

1. Manufacturer's List: Manufacturer's list shall include a typewritten list of manufacturer's name, sizes and model or catalog numbers, referenced to the specification section.
2. Manufacturer's Catalog Data: Manufacturer's catalog data shall include standard catalog information marked to indicate specific equipment proposed and point of operation, if appropriate. Include installation instructions.
3. Manufacturer's Technical and Engineering Data: Manufacturer's technical and engineering data shall include materials, dimensions, details, installation instructions, weights, capacities, illustrations, wiring diagrams, control diagrams, piping diagrams, connection diagrams, performance data (including performance curves), mix design, and any other information required for a complete and thorough evaluation of the equipment or items specified, and to verify compliance with specifications. Control diagrams or control schematics, where specified and required by the submittal schedule, shall include a detailed schematic of the proposed control modifications and their interface with existing control equipment, where appropriate, and a manufacturer and model number listing of all proposed control components shown on the control schematic.

B. Shop Drawings: Shop drawings are construction drawings of items manufactured specifically for this project. Shop drawings include dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.

C. Samples: Samples illustrate functional characteristics of the product with integral parts and attachment devices. Samples shall allow evaluation of full range of manufacturer's standard colors, textures, and patterns.

D. Certificates, Test Data or Other Information: Requirements for certificates, test data, or other information will be listed under referenced specification sections.

1.03 SUBMITTALS REQUIRED

A. Product Evaluation Data. The submittal schedule for product evaluation data is as indicated below. Each item requiring a submittal is given the following code:

1. Manufacturer's list
2. Manufacturer's catalog data
3. Manufacturer's technical and engineering data
4. Shop drawings
5. Samples
6. Certificates
7. Test data
8. Worker's qualifications
9. See individual sections for special requirements

1.04 SUBMITTAL SCHEDULE

Division 27 – Communciations	Codes
Section 27 0536 – Cable Trays for Communications Systems	1,2,3
Section 27 1000 – Access Control and Intrusion	2,3
Section 27 1126 – Rack Mounted Power Protection	2,3,4
Section 27 1313 – Copper Backbone Cabling	2,3
Section 27 1323 – Optical Fiber Backbone Cabling	2,3
Section 27 1513 – Copper Horizontal Cabling	2,3
Section 27 2000 – Voice and Data Communications	2,3
Section 27 4116 – Sound Systems	2,3
Section 27 5113 – Intercommunication Systems	2,3
Section 27 5116 – Integrated Audio Video Systems	1,2,3
Division 28 – Electronic Safety and Security	
Section 28 1000 - Access Control and Intrusion Detection System	2,3,4
Section 28 3100 - Fire Alarm System	2,3,4,9

PART 2 PRODUCTS

2.01 THIS PART NOT USED

PART 3 EXECUTION

3.01 THIS PART NOT USED

END OF SECTION

SECTION 27 0500

COMMON WORK RESULTS FOR COMMUNICATION

PART 1 GENERAL

1.01 CONTRACT DOCUMENTS

A. The Contract Documents are complementary. What is required by any one, as affects this Division, shall be as binding as if repeated herein.

B. Separation of this Division from other Contract Documents shall not be construed as complete segregation of the Work.

C. Particular attention is called to Advertisement For Bids, Instructions to Bidders, Supplemental Instructions to Bidders, General Conditions, Supplemental General Conditions, Drawings and Specifications, and modifications incorporated in the documents before execution of the Agreement.

1.02 BASIC COMMUNICATION REQUIREMENTS

A. All materials and equipment installed under this contract shall be new, unused, free of defects, and of current manufacture.

B. The Contractor shall field-investigate this facility to ascertain the exact physical and electrical conditions in the main Equipment Room (MDF), and the Telecommunications Room (IDF) locations to become familiar with the physical environment of the building.

C. The Contractor shall provide, install, and test the entire cable infrastructure as described under this contract.

D. The Contractor shall call attention to the Owner any error, conflict, or discrepancy in Plans and/or Specifications. Do not proceed with any questionable items of work until a resolution or clarification has been made. Supplemental Plans and Specifications may be supplied as required and shall become part of the Contract Documents.

1.03 SCOPE OF WORK

A. General: Provide and install complete and satisfactorily operating communications systems as specified in this Division, as shown on Drawings, as required, and as reasonably intended. Work generally includes, but is not limited to communication and alarm systems.

B. Omissions: Omission of expressed reference to any item of labor or material necessary for the proper execution of the work shall not relieve responsibility from providing such additional labor or material.

1.04 QUALITY ASSURANCE

A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where

"approved equal" is stated or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the owner or the owner representative.

C. Strictly adhere to all Telecommunications Industry Association (TIA) and BICSI recommended installation practices and manufacturer's guidelines when installing communications components.

1.05 MANUFACTURER'S WARRANTY CERTIFICATION

A. The manufacturer's certification must be supported by Contractor's successful completion of an installation class recognized by an independent organization (such as BICSI or an accredited school). A written test is strongly preferred.

1.06 TECHNICAL QUALIFICATIONS

A. Contractor must be certified by manufacturer as able to provide a 20 year (minimum) manufacturer's warranty certificate.

B. A minimum of three references demonstrating Contractor's past installation experience in Certified Category 6A systems in similar facilities with a minimum of 500 nodes shall be submitted. The Contractor must supply a one year warranty upon completion of the job.

C. At least 50% of the technicians, to include all on-site Journeymen Electricians, must have successfully completed the manufacturer's warranty certification class. D. All Journeymen are to possess a current Oregon License.

E. All Apprentices are to be actively enrolled in an Oregon State approved electrical apprenticeship program.

F. All Equipment/Telecommunication Room and Telecommunications Outlet equipment shall be installed and tested on-site by a technician(s) who, by virtue of an acceptable training course or documented experience, is qualified to perform these procedures. Acceptable training may include successful completion of the manufacturer's training course, documented on-the-job experience or successful completion of applicable technical courses in a recognized trade school.

G. Verification of the above requirements must be submitted in writing with bid.

1.07 CERTIFICATES

A. Contractor must provide evidence of ability to provide a Manufacturer's Certificate of Warranty for the system bid.

B. Contractor must provide Technician Certificate(s) for the 50% mentioned above.

1.08 EXAMINATION OF SITE

A. Examine Site of Work before making Bid and ascertain all related physical conditions.

B. Field verify scale dimensions shown since exact locations, distances and levels will be governed by actual field conditions.

C. Owner will not be responsible for any loss or unanticipated costs which may be suffered by the successful Bidder as a result of such Bidder's failure to fully inform himself in advance in regard to all conditions pertaining to the Work and character of the Work.

1.09 COORDINATION OF TRADES

A. Check Drawings of other trades to avert possible installation conflicts. Should major changes from original Drawings be necessary to resolve such conflicts, notify Architect and secure written approval and agreement on necessary adjustments before installation is started.

B. Check equipment connections and equipment locations on the job for coordination with other Divisions equipment and connections, structure, and the like.

1.10 MINOR DEVIATIONS

A. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.

1.11 SUBSTITUTIONS

A. Equal material of other manufacturer may be used following Architect's approval of a written request submitted at least 7 working days prior to bid date.

1.12 RECORD DRAWINGS

A. Maintain a marked set of prints at job site at all times. Show all changes from contract drawings, whether visible or concealed. Dimension accurately from building lines, floor or curb elevations. Show exact location, elevation, and size of conduit, access panel and doors, and all other information pertinent to the work.

B. At project completion, submit marked set to Architect for approval.

1.13 WARRANTY

A. Warrant all work, materials, and equipment for one year.

PART 2 PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and model or catalog number herein is for the purpose of establishing the product set, which the Contractor is to supply and install.

B. Quantities are to be determined by Contractor unless specified.

C. Products shall be UL® listed for the purpose they are to be used.

2.02 PRE-APPROVED PRODUCTS

A. The following products are pre-approved for this project. Except as noted, all others will require a substitution request to be completed and approved as per these documents. The District will not consider product sets that have not been pre-approved or accepted as per the substitution request process.

1. Structured Cable Systems:

   a. CommScope - all category 5e, 6 and category 6A components, i.e., jacks, patch panels, patch cords and fiber optic components.

   b. Panduit - all category 5e, 6 and category 6A components, i.e., jacks, patch panels, patch cords and fiber optic components. Partner cable, i.e., General is acceptable for the Panduit solution.

2. Racks, cabinets, frames and associated fastening devices

   a. Chatsworth Products Incorporated (CPI)

   b. Hoffman

2.03 FIRESTOPPING

A. Comply with the requirements of Section 07 8400

B. Products may be in the form of caulk, putty, strip, sheet, or devices that shall be specifically designed to fill holes, spaces, and voids at communications penetrations.

B. Firestopping materials shall also provide adhesion to substrates and maintain fire and smoke seal under normal expected movements of substrates, conduits and cables.

2.04 ACOUSTIC SEPARATION

A. Acceptable products for 2” through 4” penetrations are as follows

1. STI EasyPath™

2. Resilient latex caulk and re-enterable putty manufactured by 3M™, Specified Technologies or Hilti.

3. Or approved substitution

B. Acceptable products for less than 2” penetrations are as follows

1. Resilient latex caulk and re-enterable putty manufactured by 3M™, Specified Technologies or Hilti.
2. Or approved substitution

PART 3 EXECUTION

3.01 THIS PART NOT USED

END OF SECTION

SECTION 27 0526
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL REQUIREMENT

1.01 SUMMARY

A. This section includes the grounding and bonding requirements for the metallic components located in the Telecommunications Rooms.

1.02 SCOPE

A. Provide all labor, materials, tools, and equipment required for the complete installation of a telecommunications grounding system.

1.03 QUALITY ASSURANCE

A. All grounding and bonding cables shall be installed in a neat and workmanlike manner. C. Grounding shall meet applicable ANSI/TIA-607-B, NEC Articles 250 and 800 requirements and practices except where other authorities or codes may impose a more stringent requirement or practice. All racks and cable trays shall be bonded to a ground bar with #6 AWG cable. All termination equipment shall be grounded according to the specifications of the manufacturer.

B. Impedance shall not exceed 5 Ω between any two metallic points within a Telecommunications Room.

PART 2 - PRODUCTS

2.01 TELECOMMUNICATIONS MAIN GROUND BUS BAR – MAIN EQUIPMENT ROOM - MDF

A. A 4” x 12” x ¼” Copper bar is to be provided by Division 26. Coordinate locations with Division 26 Contractor.

2.02 GROUND BUS BAR – TELECOMMUNICATIONS ROOM - IDF

A. A 2” x 10” x ¼” Copper bar is to be provided by Division 26. Coordinate locations with Division 26 Contractor.

2.03 CABLE RUNWAY GROUNDING STRAPS

A. Continuous #6 AWG with two hole compression lugs, Chatsworth 40164-001 or approved alternate.

B. #6 AWG from bench stock is acceptable with machine compression or exothermically applied lugs.

PART 3 - EXECUTION

3.01 GENERAL

A. A copper grounding and bonding system shall be installed which places a properly sized (as per Table 250-122 of National Electrical Code) copper cable in the immediate vicinity of the telecommunications backboard. Contractor shall be responsible for placement of the above referenced ground bus bars and terminal as well as their connection to the building system grounding cable using an exothermic-welded type connector or appropriate compression applied connector to satisfy the Authority Having Jurisdiction.

3.02 PREPARATION

A. Preparation of surfaces: Clean contacting surfaces of ground connections to bright metal before connecting

B. When making bolted connection to aluminum or galvanized structures, apply a corrosion inhibitor such as Penetrox A to contact surfaces between connector, and surface of structure.

3.03 INSTALLATION

A. Grounding shall meet applicable ANSI/TIA-607-B, NEC® Articles 250 and 800 requirements and practices except where other authorities or codes may impose a more stringent requirement or practice. All racks and cable trays shall be bonded to a ground busbar with #6 AWG cable. All termination equipment shall be grounded according to the specifications of the manufacturer.

B. All metallic components that make up the equipment racks and ladder rack shall be bonded together in a manner that provides continuous continuity between the components. Attention must be given to the removal of paint of powder coating to present bare metal where bonding straps are fastened to the metallic component.

END OF SECTION

SECTION 27 0528
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL REQUIREMENT

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section. B. This section and all related sections shall be performed by a qualified Contractor as outlined in the specifications.

1.02 DESCRIPTION OF WORK

A. This contract shall be responsible for all hangers and support mechanisms required to properly support all telecommunications cables to satisfy the local Authority Having Jurisdiction.

B. This contract shall be responsible for all pathways as called out on Drawings, specifically:

1. Various conduits and “J-Boxes” as detailed on “T” and “ET” series Drawings to accommodate Telecommunications Outlets (TO) and Wireless Access Points (WAP) locations. Any necessary penetrations shall accommodate a minimum of a Trade Size 1 EMT conduit.
2. Surface mounted raceway, as per “T” and “ET” series Drawings

C. The Contractor shall coordinate with the General Contractor and all other trades prior to final placement of telecommunications pathways. Placement shall be such that pathway will be accessible for future additions requiring placement of telecommunications cable. D. The Contractor shall provide all labor, equipment and supplies to furnish and install the communications pathway, hangers and supports.

E. Installation shall include the actual physical installation of the hardware and/or support structure, firestopping, testing and documentation.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials and equipment installed under this contract shall be new, unused, free of defects, and of current manufacture. Equipment and material shall carry Underwriters Laboratory certification if required by local, state or national codes. Products are to be from the acceptable manufacturer listed below or an approved alternate. In no case will field fabrication or “shop built” cable support products be acceptable.

2.02 SURFACE MOUNTED RACEWAY

A. Surface Mounted Raceway (SMR) shall be provided as per Section 27 0528.39 with all fittings including but not limited to mounting clips and straps, couplings, flat, bend limiting internal and external elbows, cover clips, bushings, device boxes and other incidental and miscellaneous hardware required for a complete SMR system.

2.03 J-HOOKS

A. J-hooks shall be constructed of galvanized steel or hot dipped zinc.

B. Fastener is to be installed using dedicated wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments. Product is to be UL® Listed for the application.

C. Acceptable products: CADDY® CABLECAT – Wide Base Cable Support.

2.04 ADJUSTABLE CABLE SUPPORT SYSTEM

A. Cable support system shall be a factory produced assembly and sized to accommodate 100 percent expansion, i.e., rated to hold double the number of initially installed cables.

B. Acceptable product is: CADDY® CABLECAT Adjustable Cable Support

2.05 ROD MOUNTED CABLE SUPPORT SYSTEMS

A. Acceptable product is: CADDY® CAT-CM Cable Support System

2.06 FIRESTOPPING SYSTEMS TELECOM RACEWAYS

A. Comply with the requirements of Section 07 8400

B. Acceptable products for 2” through 4” penetrations are as follows

1. STI EasyPath™
2. Resilient elastomeric caulk and re-enterable putty manufactured by 3M™, Specified Technologies or Hilti.

C. Acceptable products for less than 2” penetrations are as follows

1. Resilient elastomeric caulk and re-enterable putty manufactured by 3M, Specified Technologies or Hilti.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install per manufacturer’s instruction per weight loading.

B. Install in accordance with directions given in Section 27 0529

C. SMR shall be securely supported using mechanical fasteners at intervals not exceeding 10 feet or in accordance with manufacturer’s installation instructions.

D. Telecommunication Outlets shall be surface mount outlet boxes compatible with the raceway specified.

E. The path of the SMR shall minimize impact on molding, tack boards and other architectural elements. Vertical runs of raceway from the ceiling to outlets shall be installed on walls near corners wherever possible. Raceway may be installed horizontally at the same height as the outlets or near to the ceiling. Entrance end fittings will be supplied at the ends of raceway runs to transition to conduit sleeves through walls, ceilings or floors. SMR shall be installed parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

F. Metal components shall be bonded and grounded in accordance with applicable code and ANSI/TIA-607-B.

G. J-hooks are to be supported by dedicated wires or rods installed by this contract. In no case will ceiling grid wires be used to support J-hooks. J-hooks will be attached to ceiling grid wires (where applicable) to satisfy seismic bracing requirements and to prevent swinging.

H. Adjustable cable support systems are to be securely attached to building structure and loaded as per manufacturer’s instruction.

I. Fire Rated wall and floor penetrations shall be fire-stopped in accordance with the manufacturer’s instructions using the product set referenced in 2.06 above.

END OF SECTION

SECTION 27 0529

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Raceway Supports

PART 2 PRODUCTS

2.01 RACEWAY SUPPORTS

A. Single Runs: Steel rod hangers, galvanized single hole conduit straps, or ring bolt type hangers with specialty spring clips. Plumbers perforated tape or "J-nails" not acceptable.

B. Multiple Runs: Conduit rack with 25 percent spare capacity. Maximum width per manufacturer's recommendations.

C. Vertical Runs: Channel support with conduit fittings.

D. All hardware such as inserts, straps, bolts, nuts, screws and washers shall be galvanized or cadmium-plated steel.

2.02 ANCHOR METHODS

A. Hollow Masonry and Framed Walls: Toggle bolts or spider type expansion anchors

B. Solid Masonry: Lead expansion anchors or preset inserts

C. Metal Surfaces: Machine screws, bolts, or welded studs

D. Wood Surfaces: Wood screws

E. Concrete Surfaces: Self-drilling anchors or powder-driven studs

PART 3 EXECUTION

3.01 INSTALLATION

A. Layout to maintain headroom, neat mechanical appearance, and to support equipment loads required.

B. Exact location and spacing between supports per manufacturer's recommendations and NEC requirements as minimum.

C. Conduit shall be installed in such a manner as to prevent the collection of trapped condensation. All runs of conduit shall be arranged so as to be devoid of traps wherever possible.

END OF SECTION

SECTION 27 0533
RACEWAYS AND BOXES FOR COMMUNIATIONS SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Conduit, Tubing, and Fittings

B. Flexible Conduit

C. Electrical boxes and fittings as required for a complete installation

1.02 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA)

1. NFPA 70 National Electrical Code--Chapter 3

PART 2 PRODUCTS

2.01 MATERIALS AND COMPONENTS

A. Conduit and Tubing: Galvanized steel rigid threaded conduit, electrical metallic tubing, intermediate metallic conduit.

B. Fittings:

1. General: Approved for purpose. Water, concrete tight where required.
2. Galvanized Rigid Steel Conduit (GRC): Threaded - no pressure type. Bushings with factory insulated throat.
3. Electrical Metallic Tubing (EMT): Connectors and couplings to be case steel. Preinsulated connectors and couplings shall be compression, setscrew type. All connectors shall have insulated throats.

C. Expansion Joints: Offset or sliding type with bending straps and clamps. Approved for purpose.

2.02 TYPE

A. Utilize GRC or IMC in concrete with concrete-tight connectors or exterior with watertight connectors.

B. Utilize electrical metallic tubing concealed in interior spaces or exposed in unfinished interior where not subject to physical damage.

C. Utilize surface metal raceways for exposed runs in finished areas. Paint to match wall finish.

2.03 BOXES

A. Minimum Box: 4-inch box, 1-1/2-inches deep, increase depth where required for installation of multiple conduits and conductors. Provide raised covers on bracket surface mounted outlet and plaster rings on flush outlets.

B. Three or More Devices at One Location: Use one piece gang boxes with device cover. Install one device per gang.

C. Provide galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.

D. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations. Choice of accessories is Installer's option.

2.04 PULLBOXES

A. Pullboxes and Junction Boxes: Sheet metal (indoors) or cast metal (exterior or damp locations) construction, conforming to National Electrical Code, with screw-on cover.

B. Flush Mounted Pullboxes: Provide overlapping covers with flush-head retaining screws, finished in light gray enamel.

C. Box volumes shall meet NEC for size and number of entering conduits.

2.05 SURFACE MOUNTED RACEWAY

A. Surface Mounted Raceway (SMR) shall be provided as per Section 27 0528.39 with all fittings including but not limited to mounting clips and straps, couplings, flat, bend limiting internal and external elbows, cover clips, bushings, device boxes and other incidental and miscellaneous hardware required for a complete SMR system.

2.06 J-HOOKS

A. J-hooks shall be constructed of galvanized steel or hot dipped zinc.

B. Fastener is to be installed using dedicated wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments. Product is to be UL® Listed for the application.

C. Acceptable products: CADDY® CABLECAT – Wide Base Cable Support.

2.07 ADJUSTABLE CABLE SUPPORT SYSTEM

A. Cable support system shall be a factory produced assembly and sized to accommodate 100 percent expansion, i.e., rated to hold double the number of initially installed cables.

B. Acceptable product is: CADDY® CABLECAT Adjustable Cable Support

2.08 ROD MOUNTED CABLE SUPPORT SYSTEMS

A. Acceptable product is: CADDY® CAT-CM Cable Support System

PART 3 EXECUTION

3.01 GENERAL

A. Install per manufacturer's instruction per weight loading.

B. Install in accordance with directions given in Section 27 0528.39

C. SMR shall be securely supported using mechanical fasteners at intervals not exceeding 10 feet or in accordance with manufacturer's installation instructions.

D. Telecommunication Outlets shall be surface mount outlet boxes compatible with the raceway specified.

E. The path of the SMR shall minimize impact on molding, tack boards and other architectural elements. Vertical runs of raceway from the ceiling to outlets shall be installed on walls near corners wherever possible. Raceway may be installed horizontally at the same height as the outlets or near to the ceiling. Entrance end fittings will be supplied at the ends of raceway runs to transition to conduit sleeves through walls, ceilings or floors. SMR shall be installed parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

F. Metal components shall be bonded and grounded in accordance with applicable code and ANSI/TIA-607-B.

G. J-hooks are to be supported by dedicated wires or rods installed by this contract. In no case will ceiling grid wires be used to support J-hooks. J-hooks will be attached to ceiling

grid wires (where applicable) to satisfy seismic bracing requirements and to prevent swinging.

H. Adjustable cable support systems are to be securely attached to building structure and loaded as per manufacturer's instruction.

I. Fire Rated wall and floor penetrations shall be fire-stopped in accordance with the manufacturer's instructions using the product set referenced in 2.06 above.

3.02 RACEWAY INSTALLATION

A. Install conduit concealed in all areas excluding mechanical and electrical rooms, connections to motors, connections to surface cabinets, underfloor spaces, and above suspended ceilings.

B. For exposed runs, attach surface mounted conduit with clamps.

C. Run raceways in concrete deck of floor above in areas of exposed structure at 1st floor ceilings. Elbow down to devices on underside of exposed structure. Refer to Architectural for details of floor assembly.

D. Route raceways at wood roof deck locations through roof insulation.

E. Coordinate installation of conduit in masonry work.

F. Install conduit free from dents and bruises. Plug ends to prevent entry of dirt or moisture.

G. Clean out conduit before installation of conductor.

H. Alter conduit routing to avoid structural obstructions, minimizing crossovers. Bends and offsets shall be avoided where possible, but when necessary shall be made with an approved hickey or conduit bending machine. The use of a pipe tee or a vise for bending conduit will not be permitted.

I. Provide UL approved expansion fittings complete with grounding jumpers where conduits cross building expansion joints and for long runs where conduit expansion may be excessive. Provide bends or offsets in conduit adjacent to building expansion joints where conduit is installed above suspended ceilings.

J. Route all exposed conduits parallel or perpendicular to building lines.

K. Allow minimum of 6 inches clearance at flues, steam pipes, and heat sources.

L. Vertical Runs: Straight and plumb.

M. Raceways Running in Groups: Run at same relative elevation, properly spaced and supported.

N. Dissimilar Metals: Avoid contact with pipe runs of other systems.

O. Lengths and Bends: Maximum number of bends in any run shall be the equivalent of four quarter bends (360 degrees total). Maximum length of any run shall be 300 feet, less 50 feet for each equivalent quarter bend. Junction and pull boxes shall be provided to maintain these limits.

P. Provide waterproof seal for all exterior wall and underground raceway penetrations.

Q. All empty raceways shall be provided with pull string or #12 conductor.

3.03 BOX INSTALLATION

A. Locate outlet boxes flush in areas other than mechanical rooms, electrical rooms, and above suspended ceilings.

B. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.

C. Coordinate location and mounting heights with built-in units. Adjust outlet mounting height to agree with required location for equipment served.

D. Locate pullboxes and junction boxes above suspended ceilings or in electrical rooms, utility rooms, or storage areas.

E. Support: Secure boxes independent of entering conduits by attaching directly to structure with bar hanger, blocking, or flat side bracket.

F. Identify each junction and pullbox with system description including branch circuit numbers of enclosed circuits.

G. Conduit shall be securely fastened to all sheet metal outlet, junction, and pullboxes with galvanized locknuts, and bushing.

H. Do not mount boxes back-to-back. Boxes on opposite sides of wall shall be separated by at least 3 inches.

END OF SECTION

SECTION 27 0536
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. Work Included:

1. Furnish and install complete system.
2. System to include cable tray, supports, fire wall penetrations and all other necessary accessories and installation material.

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers: Cooper B-Line, or approved.

B. Reference Standard: Conform with minimum recommendations of NEMA #VE-1.

PART 2 PRODUCTS

2.01 WIRE BASKET CABLE TRAY

A. Provide wire basket cable tray of types and sizes indicated with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the additional construction highlighted in Section 2.02.

B. All straight section longitudinal wires shall be constructed with a continuous top wire safety edge. Safety edge must be kinked and T-welded on all tray sizes.

C. Wire basket cable tray shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All mesh sections must have at least one bottom longitudinal wire along entire length of straight section. D. Wire basket cable tray sizes shall conform to the following nominal criteria:

1. Straight sections shall be furnished in standard 118.3 inch lengths.
2. Wire diameter shall be 0.196” (5mm) minimum on all mesh sections (minimum size of 4.5mm on stainless steel).
3. Wire basket cable tray shall have a 4 inch usable loading depth by 12 or 18 inches wide as called out on Drawings.

E. In order for a system to be approved as an equipment ground conductor (EGC), all splicing assemblies shall be UL® Classified or CSA approved as an EGC. When using powder coated wire mesh cable tray as an EGC, the paint must be completely removed at all contact points of splice/ground bolt attachments.

F. Material and Finishes: Material and finish specifications for are as follows.

1. Non-exposed cable tray shall be bright zinc plated, as manufactured.
2. In exposed areas, not exposed to view, the cable tray shall be white powder coat. In exposed areas, subject to view, the cable tray shall be custom powder coated to match dark grey ceiling color. Straight sections shall be powder coated with an average paint thickness of 1.2mils (30microns) to 3.0mils (75microns). Field paint supports, hangers, and accessories to match tray color.

G. All fittings shall be field formed from straight sections in accordance with manufacturer’s instructions. Where exposed, white touch-up matching powder coat shall be applied to conceal bright edges.

H. Wire basket cable tray supports shall be “L” shaped wall brackets from the manufacturer of the tray.

I. Non-wall support hangers shall be supported by ¼” inch or 3/8” inch diameter rods.

J. Special accessories shall be furnished as required to protect, support and install a wire basket cable tray system.

2.02 FIRE WALL PENETRATIONS

A. Nelson "MCT Multi-Cable-Transit", O.Z./Gedney "Fire-Seal", or approved.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install wire basket cable tray in accordance with NEMA VE 2 to ensure that the cable tray equipment complies with the requirements of the *NEC*®, applicable portions of NFPA 70B, and the National Electrical Contractors Association’s (NECA) ‘Guide to Quality Electrical Installations’ pertaining to general electrical installations practices.

B. All trays should be supported using a minimum of ¼” All Threaded Rod (ATR).

C. Special accessories shall be furnished as required to protect, support and install a wire basket cable tray system.

D. Coordinate wire basket cable tray with other electrical work as necessary to properly interface installation of wire basket cable tray with other work.

E. Support trays and fasten to structure. Install supports at each connection point, at end of each run, and at other points to maintain spacing between supports of 5 feet maximum.

F. Install firestopping in accordance with local and NFPA regulations to sustain ratings when passing wire basket cable tray through fire-rated elements.

G. Ground and bond metal cable tray in accordance with NFPA 70, National Electrical Code Article 392: Cable Trays. Additionally;

1. Bond cable tray system to a known source of building ground.
2. Provide continuity between wire basket cable tray components. Powder coating must be thoroughly removed at grounding device connection point.
3. Make connections to tray using mechanical, compression or exothermic connectors.
4. If required, ground cable trays by mounting up to two #6 AWG bare copper wires to each wire basket cable tray section, bonded with a grounding clamp

H. Provide sufficient space encompassing wire basket cable tray to permit access for installing and maintaining cables.

END OF SECTION

SECTION 27 0553
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL REQUIREMENT

1.01 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete labeling of the telecommunications infrastructure.

1.02 SCOPE

A. This section includes all telecommunications cables and the associated infrastructure in the telecommunications rooms and telecommunications cabinets.

1.03 QUALITY ASSURANCE

A. All cable identification tags and labels shall be installed in a neat and workmanlike manner.

PART 2 - PRODUCTS

2.01 LABEL TAGS – CABLE AND FACEPLATES

A. The labels shall be machine generated.

B. The label background shall be white with either black or blue ink. C.

Lettering on sleeves shall be $^{1}/_{8}$-inch high

2.02 ENGRAVED SIGNAGE

A. Engraved signage shall be laminate (color as specified) with engraved white letters.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. All horizontal (station) cables and outlets in which they terminate shall be identified by the Contractor at both ends of the wiring run. The standard nomenclature for the labeling is Classroom Number.Position.Port Number, hereafter known as CN.P.NN.
2. All fiber tie cables shall be labeled at each end. The standard nomenclature for labeling is “From <Room-1> to <Room-2>”, where “Room-1” is the originating location and “Room-2” is the destination.
3. Room numbers used for equipment labeling are to reference Architectural Signage Plans.

B. Telecommunication Room and Telecom Enclosures shall be identified with building room numbers

C. Horizontal (Station) Cables

1. All cables will be labeled the same at both ends. The tag shall be secured to the sheath no more than 4 inches from the end of the cable. Each end of the UTP horizontal cables shall be labeled with the nomenclature “CN.P.NN”. Where CN indicates the Classroom Number, P indicates the relative position within the room, and NN indicates the port number.
2. Relative position identification shall commence to the immediate left of the entrance door with the position identifier starting at “A” and increasing through the alphabet in a clockwise direction.
3. Port numbers shall be “1” – “x”, where x is the total number of ports on a plate.
4. Examples;

i. 101.A.1-3 - would be the first telecommunications outlet in room 101 and have three ports
ii. 101.B.1-4 - would be the second telecommunications outlet in room 101 and have four ports
iii. 101.C.1-2 - would be the third telecommunications outlet in room 101 and have two ports

D. Copper Tie Cables

1. Cables shall be labeled “From” – “To”, specifically:

   From ER to TR-x, where “x” = TR Number

E. Fiber Tie Cables

1. Cables shall be labeled “From” – “To”, specifically:

   From ER to TR-x, where “x” = TR Number

F. Telecommunication Outlets (TO)

1. Each TO shall be labeled at the top of the modular jack enclosure with the “CN.P.NN” nomenclature.

G. Telecommunications Racks and Frames

1. Labeling in the Main Equipment Room and Telecommunications Rooms shall be as per the Drawings. Labels shall be 1” blue laminate with ½ inch white letters. Labels shall be placed left-to-right identifying “FRAME-1” through “FRAME-x”, where “x” = number of racks/cabinets present.

H. Patch Panels

1. Patch panels shall be labeled identical to the cables and telecommunications outlets.

I. Door Signage

1. The exterior door of the Main Equipment Room (ER) and Telecommunications Rooms (TRs) shall have signage as per the drawings.

END OF SECTION

SECTION 27 1126
COMMUNICATIONS RACK MOUNTED POWER PROTECTION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

B. Install Uninterruptable Power System (UPS) as per documents and Drawings.

C. Provide and install power distribution as per documents and Drawings.

D. Install network management card(s) and verify connectivity to Owner's network.

1.02 QUALITY ASSURANCE

A. All equipment shall be installed in a neat and workmanlike manner.

B. All materials shall be installed per standard installation practices and manufacturer's specifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. Quantities are to be as called out on Drawings.

B. All products must be new and UL Listed for their use.

C. Liebert and Emerson are synonymous in this in this Section.

2.02 UNINTERRUPTABLE POWER SYSTEMS

A. Units are Owner Furnished, Owner Installed, Contractor connected.

B. 2200VA UPS – Owner Approved are:

1. APC Smart-UPS RT 2200VA - Rack Mounted 120V, APC Part Number SURTA2200RMXL2U.

2. Liebert GXT3 1500VA/1350kW – Rack Mounted 120V, Liebert Part Number GXT3-2000RT120.

C. 3000VA UPS - Approved are:

1. APC Smart-UPS RT 3000VA - Rack Tower 120V, APC Part Number SURTA3000RMXL3U

2. Liebert GXT3 3000VA/2700kW – Rack Tower 120V, Liebert Part Number GXT33000RT120.

D. 5000VA UPS – Approved are:

a APC Smart-UPS RT 5000VA RM 208V to 208/120V, APC Part Number SUA5000R5TXFMR.

b Liebert GXT3 5000VA/4000kW – Rack Tower 208V to 120/208V, Liebert Part Number GXT3-5000RT208. Power Distribution Box PD2-101 must be included if this UPS is selected.

2.03. ENVIRONMENTAL MONITORING AND NETWORK INTERFACE MODULE

A. All UPS units will be equipped with a network management card with environmental monitoring. Approved are:

1. APC Part Number AP9631.

2. Liebert IntelliSlot Webcard Part Number IS-WEBCARD

2.04 POWER DISTRIBUTION UNITS

A. One per rack in all Telecommunications Rooms. - Approved are:

1. Rack PDU, Basic, Zero U, 15A, (14) 5-15, APC Part Number AP9567
2. Rack PDU, Knurr DI Strip, 15A, (12) 5-15, Part Number 035351021

PART 3 - EXECUTION

3.01 GENERAL

A. Follow manufacturer's instruction in terms of moving and mounting. These units will, in all likelihood, require two people to safely mount into the prescribed racks/cabinets.

B. Bond all TVSS components as per manufacturer's instruction.

C. Units are to be powered on and batteries fully charged prior to any load testing whatsoever including the energizing of Owner supplied active electronics.

3.02 INSTALLATION

A. 2000/2200VA

1. UPS to be installed in lowest position of rack in the TR.
2. UPS to be installed in the lowest position of the wall mounted cabinets.
    a. The input for the UPS 120 Volt, 20 amps and requires a NEMA 5-20 receptacle.
3. Rack PDU – install one on each side on rear rails with supplied brackets in the rack allocated to Owner Supplied / Active Electronics. Energize from UPS.
4. Route network interface cable and output power cables in overhead ladder tray.
5. Network Management Card – install in each UPS. Connect to designated port on District supplied Ethernet switch. Verify link light on card.

B. 3000VA

1. UPS is to be placed in the bottom most position of the four-post rack in the Main Equipment Room.
    a. The input for the UPS 120 Volt, 30 amps and requires a NEMA L5-30 receptacle. This Contract is responsible for and must coordinate with Electrician for placement of this receptacle.
2. Rack PDU – install one on each side on rear rails with supplied brackets in the rack allocated to Owner Supplied / Active Electronics. Energize from UPS
3. Route network interface cable and output power cables in overhead ladder tray.
4. Network Management Card – install in each UPS. Connect to designated port on District supplied Ethernet switch. Verify link light on card.

C. 5000VA

1. UPS is to be placed in the bottom most position of the four-post rack in the Main Equipment Room (MDF) and the four-post rack in the IT Area.
    a. The input power for these units is 208/240 Volt. The APC comes with an 8 foot power cord and requires a NEMA L6-30R receptacle. The Liebert unit is designed to be hard wired. This contract is responsible for selection of the proper method of power to match the unit selected. This contact must coordinate with electrician for placement of receptacle or in the case of hard wire, coordinate the 208/240 Volt connection.
2. Rack PDU – spaced across the rear of the racks with supplied brackets in the rack(s) allocated to Owner Supplied / Active Electronics. Energize from UPS.
3. Route network interface cable and output power cables in overhead ladder tray.

4. Network Management Card – install in UPS. Connect to designated port on District supplied Ethernet switch. Verify link light on card.

END OF SECTION

SECTION 27 1313
COPPER BACKBONE CABLING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.02 SCOPE

A. This section includes the copper backbone cable and the termination requirements.

B. Multi-pair copper cables shall be installed between the Main Equipment Room (ER) and each Telecommunications Room (TR). Cables shall be terminated on 110 blocks in the ER and extended to rack mounted 24-port patch panels in each of the TRs.

1.03 QUALITY ASSURANCE

A. See Section 27 0513

B. All cable shall be installed in a neat and workmanlike manner.

PART 2 - PRODUCTS

2.01 UTILITY SUPPLY CABLE

A. The utility supply cable shall be six, category 6A, 4-pair unshielded twisted pair cables.

B. The cable shall be 24 AWG with a jacket rated for installation in under-slab ducts.

2.02 PATCH PANEL

A. Utility Supply, 24 port panel, rated for Category 6A.

2.03 110 BLOCKS

A. 100 pair with legs utilizing C-5 clips

PART 3 - EXECUTION

3.01 GENERAL

A. Cable ties must be finger tight. The cable tie must not distort the outer jacket.

B. The bend radius shall be no less than 10 times the outside cable jacket.

C. Only Velcro-type wraps shall be used to bundle cables on the back of the equipment racks and in the cable trays located in the Telecommunication and Equipment Rooms.

3.02 PREPARATION

A. Conduits

1. All conduits and sleeves shall be inspected for bushings prior to cable installation. Missing bushings shall be brought to the attention of the Owner.

3.03 INSTALLATION

A. Copper Riser Cable

1. Cables shall be installed between punch down blocks in the Main Equipment Room (MDF) and Telecommunications Rooms (IDFs).
2. The punch down side of the cable shall be terminated 110 blocks with C-5 clips. 110 blocks are to be placed on the telecommunications backboard in the main equipment room as per the drawings.
3. 24 port utility supply patch panels shall be placed as per the Drawings in each of the Telecommunications Rooms.

a. Provide (1) in the MDF and (1) in each of the IDFs.

4. Place six cables from the 110 block in each room to the patch panel. Terminate all four pairs.

C. Label 110 blocks and patch panels “UTILITY FEED TO IDF-x”, where X = IDF Number, specifically “IDF-1”, “IDF-2” or “IDF-3”

END OF SECTION

SECTION 27 1323
COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.02 SCOPE

A. This section includes the fiber backbone cable and the termination requirements.

1.03 QUALITY ASSURANCE

A. See Section 27 0500

B. All cable shall be installed in a neat and workmanlike manner.

PART 2 - PRODUCTS

2.01 FIBER OPTIC CABLE

A. Multimode fiber shall be 50/12mm Laser Optimized multimode (OM3). Strand count shall be as per Drawings. Rating shall be suitable for applications with a minimum rating of OFNR. Factory terminated, pre-connectorized assemblies are preferred.

2.03 READER BOARD FIBER

A. This contract will place a four-strand multimode fiber between the MDF and the Reader Board. Fiber will be placed using a two-cell Maxcell innerduct. A Trade Size 2 conduit will be installed by others as a pathway for the fiber and innerduct.

2.04 FIBER OPTIC TERMINATION

A. Fiber termination equipment will be:

1. 2U frame. Approved is Panduit part number FRME2U. Place one in each IDF. Two will be required in the MDF. One shall be used to land fiber from the IDF locations (multimode) and the other shall be used to land the single mode fiber.
2. Multimode fiber shall terminate on LC fiber adapter panels. Approved is Panduit part number FAP6WAQDLCZ. Quantities as required
3. Single mode fiber shall terminate on LC Fiber adapter panels. Approved is Panduit FAP12WBULCZ
4. Blank panels shall be used to cover all unused openings in the frames. Approved is Panduit part number FAPB.
5. Reader board fiber will be terminated as follows:
   a) Terminate fiber using duplex LC connector modules. Approved is Panduit part number CMDJAQLCZBL.
   b) Place fiber modules in surface mount box. Approved is Panduit UICBX4IW-A.

PART 3 - EXECUTION

3.01 GENERAL

A. Cable ties must be finger tight. The cable tie must not distort the outer jacket.

B. The bend radius shall be no less than 10 times the outside cable jacket.

C. Only Velcro®-type tie wraps shall be used to bundle cables on the back of the equipment racks and in the cable trays located in the Telecommunication and Equipment Rooms.

3.02 PREPARATION

A. Conduits - all conduits shall be inspected for bushings prior to cable installation.

3.03 INSTALLATION

A. Install per manufacturer's instructions.

B. Install the fiber optic cable by hand or by using a mechanical pulling machine. If a mechanical pulling machine is used, equip the machine with a monitored or recording tension meter. Ensure that at no time the manufacturer's recommended maximum pulling tension is exceeded. Ensure that the central strength member and aramid yarn are attached directly to the pulling eye during cable pulling. Use pulling attachments, such as "basket grip" or "Chinese finger" type, to ensure that the optical and mechanical characteristics are not degraded during the fiber optic cable installation.

C. Ensure that excess cable is coiled in a figure eight and fed manually when pulling through pull boxes and splice boxes by hand. If pulleys and sheaves will be used to mechanically pull through pull boxes and splice boxes, provide a drawing of the proposed layout showing that the cable will never be pulled through a radius less than the manufacturer's minimum bend radius. Use large diameter wheels, pulling sheaves, and cable guides to maintain the appropriate bend radius. Provide tension monitoring at all times during the pulling operation. Ensure that cable pulling lubricant used during installation is recommended by the optical fiber cable manufacturer.

D. Label fiber patch panels in the MDF as: "Feed to IDF-x", where x = IDF number

E. Label fiber patch panels in the IDF as "Feed from MDF"

F. Coordinate placement of fiber within the Reader Board with General Contractor.

G. Place Reader Board surface mount box on backboard in MDF. Provide a 20' slack coil of fiber. Label fiber and mounting box as "READER BOARD".

END OF SECTION

SECTION 27 1513
COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

B. Install horizontal cable as outlined on drawings and specifications. Also included is sleeves for any ceiling or wall penetrations not provided by the General or Electrical Contractor; fire stopping as directed by the most stringent of these specifications or code; and all support structure needed to install the above components.

C. Verify actual counts on prints and drop detail.

1.02 SCOPE OF WORK

A. It is the intent of this section for the Contractor to provide a complete workable cabling system ready for the Owner's use in accordance with the latest current version of ANSI/TIA-568 standards to support high speed data applications up to 10Gbs including IEEE 802.3x system standards.

1.03 QUALITY ASSURANCE

A. All cable shall be installed in a neat and workmanlike manner.

B. Strictly adhere to all category 6A installation practices when installing horizontal cabling.

PART 2 - PRODUCTS

2.01 GENERAL

A. The horizontal UTP cabling system shall be a Category 6A warranted link system, including the patch cords, patch panels, cables, and telecommunications outlets.

2.02 COPPER CABLE

A. The horizontal copper cable supporting all locations except as noted on Drawings, shall be 4-Pair balanced twisted pair rated for category 6A. Color to be dark blue.

B. Cable supporting locations identified as Wireless Access points (WAP) and so noted as a circled “W” on the Drawings, shall be 4-Pair balanced twisted pair rated for category 6A. Color to be yellow.

C. Cable called out as category 6A shall be shall be 4-Pair balanced twisted pair. Jacket shall be white in color.

D. Backbone cable shall be 4-Pair balanced twisted pair rated for category 6A. Jacket shall be rated for wet locations and black in color.

PART 3 - EXECUTION

3.01 GENERAL

A. Cable ties must be finger tight. The cable tie must not distort the outer jacket.

B. The bend radius shall be no less than 4 times the outside cable jacket diameter for the horizontal UTP cable and 10 times the outside cable jacket diameter for both the fiber and multi-pair copper riser cable.

C. Only Velcro® (hook and loop) type cable wraps shall be used to bundle cables on the back of the equipment racks and in the cable trays located in the Telecommunication and Rooms.

3.02 PREPARATION

A. Conduits

1. All conduits and sleeves shall be inspected for bushings prior to cable installation.
2. Missing bushings shall be brought to the attention of the owner or authorized representative.

3.03 INSTALLATION

A. Copper Horizontal Cables

1. Installation shall be in a manner to meet the specifications as outlined by the cable manufacturer for the product set being installed.
2. Copper horizontal cables shall be pulled from the TR to the workstation.
3. Service loops of
   a. 10 feet minimum shall be left coiled high as high as possible in the MDF or IDF.
   b. 10 feet of slack shall be neatly coiled and secured with Velcro® at the telecommunications outlet (typically in the ceiling) used for Wireless Access points
   c. Placement of service loops subject to verification by Owner.
4. Location and label shall be annotated on the as built drawings.
5. Locations coiled for wireless shall have ½" black on white labels placed below the outlet on the ceiling grid.

END OF SECTION

SECTION 27 1619
COMMUNICATIONS PATCH CORDS AND STATION CORDS

PART 1 - GENERAL REQUIREMENT

1.01 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

PART 2 - PRODUCTS

2.01 FIBER PATCH CORDS - MULTIMODE

A. The Contractor shall supply the fiber-optic patch cords in the quantities listed. Each patch cord shall be a duplex LC connector to duplex LC connector. The patch cords shall be made from Laser Optimized (OM4) 50/125mm multimode fiber and shall be aqua in color.

Length	1M	2M	3M
Quantity	10	4	4

2.02 FIBER PATCH CORDS – SINGLE MODE

A. The Contractor shall supply single mode patch cords in the quantities listed. Each patch cord shall be a duplex LC connector to duplex LC connector. The patch cords shall be yellow in color.

Length	1M	2M	3M
Quantity	4	4	4

2.03 COPPER PATCH CORDS

A. The Contractor shall supply the patch cords in the quantities listed. Each patch cord is a stranded 8-pin modular plug to an 8-pin modular plug cable. The sheath and boot shall be gray in color and rated category 6A

Length	3’	5’	7’	10’	14’	25’
Quantity	90	150	150	100	75	25

2.04 WAP PATCH CORDS

A. The Contractor shall supply the patch cords in the quantities listed. Each patch cord is a stranded 8-pin modular plug to an 8-pin modular plug cable. The sheath and boot shall be white in color and rated category 6A

Length	1	2	3’	5’	7’
Quantity	75	50	25	35	35

2.05 VOIP PATCH CORDS

A. The Contractor shall supply the patch cords in the quantities listed. Each patch cord is a stranded 8-pin modular plug to an 8-pin modular plug cable. The sheath and boot shall be black in color and rated category 6A

Length	3’	5’	7’	10’	14’	25’
Quantity	30	30	30	15	10	5

PART 3 - EXECUTION

3.01 GENERAL

A. Deliver all patch cords in sealed cartons to Owner. Coordinate with Owner for delivery schedule and locations.

END OF SECTION

SECTION 27 2000
VOICE AND DATA COMMUNICATIONS

PART 1 - GENERAL

1.01 SCOPE

A. Provide and install (1) CAT-6A cable from wireless locations to the Telecommunication Closet serving the area. Provide and install necessary cable pathways and conduits as shown on drawings.

B. Drawing depicts the general location of the access points. Include provisions for adjusting location up to 15 feet in either direction at no additional cost to Owner.

C. The Contractor shall provide all necessary project management, labor, materials, equipment, services, and other items required, whether specified or not, to furnish a complete and functional cabling installation. Among the items required are;
   1. CAT-6A cable, unshielded, twisted-pair and termination hardware.
   2. CAT-6A data patch panels in the MDF and IDF Rooms for terminating horizontal cable.
   3. Outlet devices and faceplates.
   4. Labeling in MDF Room, IDF Room(s), and at station locations.
   5. Installation, test data, and results.

1.02 QUALITY ASSURANCE

A. Contractor Qualifications
   1. It is required that the Contractor shall have Systimax, Panduit, and Commscope certifications with not less than 50% of staffed technicians trained in Systimax structured cable systems. Contractor must supply documentation as proof that this requirement is met prior to award.
   2. Work in this section shall be performed by a low-voltage Contractor with demonstrated experience in the installation of inside and outside plant cabling.
   3. The Contractor shall have demonstrated experience in the installation and testing of all cable plant components specified herein.
   4. The Contractor shall have installed cable plant in buildings similar in size and scope to this project.

1.03 WARRANTY

1. Guarantee all work against faulty and improper material and workmanship for a minimum period of one (1) year from the date of final written acceptance by the 4J School District, except where guarantee or warranties for longer terms are specified herein.
2. Contractor is to provide a 25 year Systimax warranty for the work performed on this project.
3. Upon notification of a problem, the warranty provider shall furnish within 48 hours and at no cost to the 4J School District, such labor and materials as are needed to restore the system to proper operation.

1.04 REGULATORY REQUIREMENT

A. All work shall be performed in accordance with the latest revisions of all national and local governing codes and standards, including:

Uniform Building Code	State of Oregon Edition (UBC)
NEC	National Electrical Code

NFPA 75	Protection of Electronic Computer and Data Processing Equipment
NFPA 78	Lightning Protection Code
NFPA 101	Life Safety Code
FCC Part 68	Connection of Terminal Equipment to Telephone Network
ANSI/TIA/EIA	American Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance

PART 2 - PRODUCTS

2.01 INTRODUCTION

A. All materials constituting the data, facility shall conform to the specifications herein.

B. All products shall be new and shall be brought to the job site in original manufacturer's packaging. Electrical components shall bear the Underwriter's Laboratories label. All communications cable shall bear the manufacturer's label in accordance with NEC 800 based on flammability testing as follows:
   1. CMP Plenum-rated Communications Cable

2.02 PRE-APPROVED PRODUCTS

A. The following product sets only are approved for this project.
   1. Racks, cabinets, enclosures, frames and associated fastening devices: Chatsworth Products Incorporated (CPI)

2.02 TELECOMMUNICATIONS RACK

A. Freestanding telecommunications racks shall be installed in the Telecommunications Rooms.

B. Racks shall be Chatsworth 7' x 19". Part 55053-703

C. Chatsworth 3" channel rack-to-runway mounting plate with bracket. Part 12730-712

D. Chatsworth cable runway radius drop, Part 12100-712

2.03 TELECOMMUNICATIONS RACK – FOUR POST

A. Four-post server racks shall be installed in the Telecommunications Equipment Rooms.

B. Racks shall be Chatsworth 7' x 19" x 40" (D), Part 15214-703

C. Chatsworth Runway Mounting Bracket, Part 15205-701

D. Chatsworth Equipment Support Rails, Part 15235-706

2.04 LABELING

A. Telecommunications Racks and Frames
   1. Labeling in the Main Equipment Room and Telecommunications Rooms shall be as per the Drawings. Labels shall be 1" blue laminate with ½ inch white letters. Labels shall be placed left-to-right identifying "FRAME-1" through "FRAME-x", where "x" = number of racks/cabinets present.

2.02 CHANNEL RACK-TO-RUNWAY

A. Use a Channel Rack-to-Runway Mounting Plate Kit to securely attach 12" wide cable tray to equipment rack. A kit from Chatsworth includes all necessary bolts, washers, and nuts to make the attachments. CPI Part 12730-712

2.03 HORIZONTAL WIRE MANAGEMENT

A. Horizontal cabling managers shall be used to organize and contain patch cord runs from patch port to vertical cable wire management. Manufacturer to be same as structured cabling system.

B. Double (3.5') RMU units only are acceptable and are to be supplied at the rate of 1 RMU per each 24 ports of patch panel.

2.04 VERTICAL CABLE MANAGEMENT

A. Vertical cable managers shall be installed as per Drawings. CPI 11729-703

2.05 EQUIPMENT SHELF

A. Provide equipment shelf, CPI 40074-700 at the rate of one per rack. Deliver in unopened carton to Owner.

2.02 HORIZONTAL CABLE

A. The following paragraphs describe the cabling for data wireless station outlets.
   1. One (1) 24AWG, 4-pair, unshielded, twisted-pair cable at each location unless specified on the drawings.
   2. For Wireless CAT 6A: CMP rated: Systimax 2061 White, Material ID: 106946825

2.03 WORKSTATION OUTLET DEVICE

A. The termination jack for the standard connections shall be an 8-pin (4 pair) modular jack T568A rated for category 6A. Jacks shall be different colors and installed as follows:
   a. Upper left – black
   b. Upper right – gray
   c. Lower left – gray
   d. Lower left - blank

B. At the outlet location, approximately 6-9 inches of slack cable shall remain to facilitate servicing after the installation.

C. Termination for cables supporting WAPs is to be made using a white category jack. Each WAP location shall be two cables placed in a white, two port biscuit box.

D. Termination for cables supporting WAPs shall provide a 20 foot slack loop to be coiled and secured with Velcro®. Biscuit box shall be affixed to structure.

2.04 STANDARD OUTLET BOX

A. If possible, every effort is to be made to conceal cabling inside walls with a single-gang cut-out. Product: Enrico Material ID: MP-1

B. The standard outlet box is a 5.0-inch by 3.3-inch by 1.6-inch surface-mounted electrical outlet box. Product: Panduit 2-piece Low Voltage Surface Mount Outlet Box, Off White, Material ID: JB3510IW-A

2.05 TELECOMMUNICATIONS OUTLET FACEPLATE

A. The standard Telecommunications Outlet faceplate consists of Product: Systimax M10L-246 1-Port Faceplate, Ivory Material ID: 108258419

B. The faceplate will house the termination for a Category 6A 4-Pair UTP cable for data. Product: Systimax MPS100E-270 Cat 6A, RJ-45 Insert, Gray, Material ID: 108232752

2.06 DATA CABLING MDF and IDF PATCH PANELS

A. For Cat 6A cable; Products: Systimax, Model 1100PSCAT6A [24-port], Material ID:10808919 or Systimax, Model 1100PSCAT6A [48-port], Material ID:108208935

2.02 PUNCHDOWN BLOCKS

A. 100 pair 110 type punch down blocks with legs.

B. 5 pair connecting clips

2.03 PATCH PANELS

A. 8-pin modular Category 6A 24 or 48 port for access control applications.

B. 8-pin modular Category 6A (Copper Risers) 24 or 48 port for voice and utility applications.

C. 8-pin modular Category 6A (Station Cables) 24 or 48 port for data cabling.

2.08 ASSOCIATED PRODUCTS

A. Fire stopping
   1. Products: T&B Flame Safe Compound, 3M Fire Barrier Caulk

PART 3- PRACTICES

3.01 PRODUCT INSPECTIONS

A. All products shall be inspected prior to installation to verify that they are of proper gauge, contains the correct number of pairs, and otherwise meets specifications. Any physical damage to products is unacceptable. Uniform jacket thickness, tightness, or buckling should be checked. All outlet devices, cross-connect blocks, and other components shall also be inspected prior to installation.

3.02 SERVICE INTERRUPTION

A. The Contractor shall prevent interruption of service by identifying and providing temporary supports and protection of existing communications cables, cross-connect blocks, and equipment throughout demolition and construction. In the event existing active communications cabling, outside the scope of the project, needs to be relocated, the Contractor shall immediately notify CIS.

B. If accidental interruptions do occur, the Contractor shall immediately notify CIS coordinator so that service may be re-established as soon as possible.

3.03 CABLE INSTALLATION

A. General
   1. The Contractor shall ensure that communications cable is installed with care, using technique which prevent kinking, sharp bends, scraping, cutting, or deforming the jacket, or other damage. Installation shall be subject to periodic inspections by 4J School District. The Contractor shall replace unacceptable cable at no additional expense to the District.

B. Routing
   1. All cabling shall be routed so as to avoid interference with any other service or system, operation, or maintenance purpose (e.g., access boxes, ventilation mixing boxes, access

hatches to air filters, switch or electrical outlets, electrical panels, fire alarm equipment, clock systems, and lighting fixtures).

2. The installation of cable around movable devices, instruments, sub-panels, etc., shall be provided with adequate support, length, protection, and flexibility so that the cable is not damaged in the event the equipment is moved.

C. Pull Lines
   1. A 3/32-inch diameter, 200-pound strength polyethylene pull line shall be installed in all communication system conduit, both empty and with cable. This provides a pull line available for the next cable installation. Each end of the pull line shall be secured.

D. Cable Bend Radius and Pull Tension
   1. Communications cable cannot tolerate sharp bends or excessive pull tension during installation. Contractor shall observe manufacturer's recommended bend radius and pull tension for all cable.

E. Cable Lubricants
   1. Lubricants specifically designed for installing communications cable may be used to reduce pulling tension as necessary when pulling cable into conduit. After installation, exposed cable and other surfaces shall be cleaned free of lubricant residue.

F. Cable Support
   1. All cable shall be supported every 4 feet vertically and horizontally. Backbone cables shall be supported at each penetration. Cables shall be organized neatly, by system (voice/data/catv, etc.), and separately supported "D-rings" shall be used to support cable vertically and horizontally by means of D-rings screwed to the outside edge(s) of the backboard. Installation of these supports shall be done with care, so as not to cause crushing or distortion of the cable or result in tighter radius bends than the minimum radius permitted for each type of cable. Cable not dressed in a neat fashion of installed with excessive slack shall be rejected.

G. Penetrations
   1. Not less than a ¾-in EMT conduit shall be used when penetrating inside walls from corridor to classrooms. Conduits shall be reamed and free of burrs and have bushings installed at both ends before cable is pulled.
   2. Not less than a 2-in EMT conduit shall be used when penetrating walls to the MDF and IDF Rooms or outside pathways. Conduits shall be reamed and free of burrs and have bushings installed at both ends before cable is pulled.

H. Cable Removal
   1. All communications cable that has been decommissioned, slated for demolition or otherwise found abandon, shall be removed from ceiling spaces, conduit, cable tray, and other raceway

3.01 GENERAL REQUIREMENTS – RACKS

A. Racks shall be firmly affixed to the floor using anchors and Grade 5 bolts.

B. Top of rack shall be firmly affixed to ladder tray by means of a mounting plate as detailed in Section 27 1123.

C. Rack shall be bonded to adjacent assemblies as detailed in Section 27 0526.

D. All metallic components shall be bonded as per 27 0526.

E. A two RMU horizontal wire management panel shall be installed at the top of the rack. Additional horizontal wire management shall be installed as described above.

3.04 CONDUIT USAGE and FILL

A. Dedicated Use
   1. Communications cable shall not share conduit with electrical power wiring, fire alarm or intercom system wiring, or any other building system.

B. Fill
   1. Communications conduit shall not be filled beyond 40% capacity. Refer to NEC for conduit capacity for various trade sizes of conduit.

C. Cable Lubricants
   1. Lubricants specifically designed for installing communications cable may be used to reduce pulling tension as necessary when pulling cable into conduit. After installation, exposed cable and other surfaces shall be cleaned free of lubricant residue.

3.05 CABLE TRAY USAGE and FILL

A. General
   1. Contractor shall not attach any devices, raceway, or other building systems to sides or bottom of cable tray without prior approval from 4J School District.

B. Fill
   1. Communications cable shall be installed in cable tray as indicated in the Contract Documents. Cable tray fill shall not exceed 40% of total tray cross-sectional area per NEC.

C. Transitions
   1. Install cable so that entry to and exit from tray is supported by drop-out plates or other listed devices installed to ensure cable is not stressed at the point at which it enters or exits the tray. Where the cable bundle makes the transition from conduit to cable tray, the cables shall drop, as much as possible, perpendicular to the tray. (They shall not slope to a point more than one foot along the tray.

D. Dressing
   1. Wherever cable tray is exposed in hallways, whether completely visible or partially concealed, extra care shall be taken to neatly dress all cable between the conduit and the tray. Do not secure cable in bundles while inside the tray. Cable shall remain loose, not bound, but neatly managed in tray. In the MDF and IDF cables will be bundled using Velcro only.

E. Fire-Stopping
   1. During the final review and inspection period, following the 4J School District inspection of cable installed and tested acceptable, but prior to substantial completion, all sleeves passing through floors, roofs, and exterior walls shall be filled with approved fire-stop material in accordance with NEC 300-21. All firewall penetrations shall likewise be filled with suitable fire-stop material. Unused sleeves shall be capped or grouted.
   2. In situations where cable tray, conduit, or sleeves extend outside the construction area into occupied portions of the building, they shall be capped or fire-stopped throughout the course of construction.

   3. The ancillary space around all sleeves passing through fire-rated construction shall be sealed with approved fire-stop material in accordance with NEC 300-21. Unused sleeves shall be sealed with approved fire-stop material. UL listed fire-rated conduit caps may be

used to seal unused sleeves and conduit except where conduits have grounding bushings.

4. In situations where cable tray, conduit, or sleeves extend outside the construction area through fire-rated construction, they shall be capped or sealed throughout the course of construction.
5. Where conduits extend through walls to the exterior of buildings, conduits shall be sealed with weatherproof material or capped. Unused conduits in outside cable plant pull vaults or duct banks shall be capped.

3.06 TERMINATIONS

A. 110 blocks shall be labeled as per criteria provided on Drawings and Section 27 0553

B. A one RMU horizontal wire management panel shall be installed at the top of each rack used for copper backbone cables. Additional horizontal wire management shall be installed at a rate of one RMU per each 24 port panel installed.

3.07 HORIZONTAL CABLE PLANT

A. Cable Installation and Routing
   1. All cabling shall be routed so as to avoid interference with any other service or system, operation, or maintenance purpose (e.g., access boxes, ventilation mixing boxes, access hatches to air filters, switch or electrical outlets, electrical panels, fire alarm equipment, clock systems, and lighting fixtures).

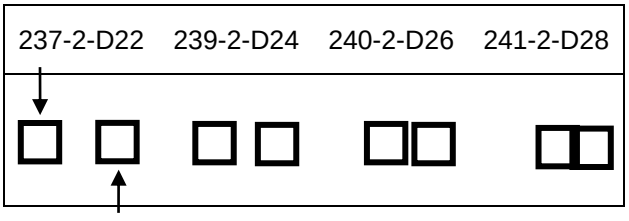
B. Cable Terminations
   1. Unless noted otherwise, termination hardware shall be grouped in rows and columns. No termination hardware shall be located closer than 12 inches from a corner. The top edge of the termination hardware shall be 62 inches above the finished floor. The termination hardware shall be grouped by application (i.e. voice and data), and arranged with from left to right, top to bottom. Adequate space shall be provided adjacent to voice and data termination hardware to allow for future growth. Termination hardware space is allocated for each cabled communication outlet.
   2. Data station cable shall be terminated left to right on a patch panel.

C. Cable Identification
   1. All station cables shall be labeled. Labels shall be typed in a permanent and legible fashion and securely attached. Cable shall be labeled in the MDF/IDF Rooms on the termination hardware at both ends. The Contractor shall securely affix labels to both ends of each cable identifying the cable.

D. Horizontal Cable Termination in MDF/IDF Labeling
   1. Each Patch Panel jack is identified by a unique number. The basic methodology for the jack's identification is as follows:

Room number	237
IDF number	2
Jack Type (V=voice/D=Data)Sequence number	D22

Data Patch Panel Example

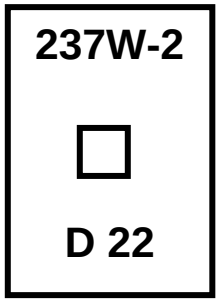


238-2-D23	239-2-D25	240-2-D27	241-2-D29

E. Horizontal Cable Termination at Workstation
1. All faceplate identification shall be consistent with the numbers on the Telecommunication Outlet Schedule included in the Attachment. Document grid numbers are unacceptable. 4J School District-assigned room numbers shall be used.
2. All plastic faceplates shall have a typed label securely attached to the faceplate indicating that location's ID number

F. Labeling
1. All faceplates shall be labeled. The typed labels shall be legible, permanent and securely attached to the respective faceplate. Position the room and the IDF number centered at the top of the faceplate and the outlet number at the bottom of each outlet.

Example:



3.08 TESTING

A. General
1. Acceptance of the simple test procedures discussed below is predicated on the Contractor's use of the recommended products (including, but not limited to, twisted-pair, fiber and coaxial cable, and outlet devices specified in the Products paragraph), and adherence to the inspection requirements and practices set forth.
2. At a minimum, the Contractor shall test:
3. All horizontal cable from MDF/IDF termination points to outlet device.

B. Horizontal Cable Testing
1. All testing shall be done using the permanent link parameters.
2. All pairs shall test "pass" and meet appropriate performance parameters. Open, split, mis-terminated pairs, deviations from the manufacturer's installation specifications, defective connections and bad installation practices shall not be accepted and shall be corrected. Test 100% of all station cable.

3. Test results shall meet or exceed the performance test requirements as specified in the current ANSI/TIA/EIA specifications.
4. Provide complete documentation of all tests. Documentation shall include outlet number, and results of performance testing done with the cable analyzer. Analyzer documentation of testing shall consist of test result recorded in a ".txt" or ".csv" file on IBM formatted 3.5 inch disks or archived on to a CD-ROM. Test results shall be submitted and approved prior to substantial completion and final payment approval.
5. The Contractor shall undertake post-installation testing of all copper cabling. Fluke DSP-1800 certification and summary (or an approved equivalent) must be provided for all Category 6A.

6. All cable paths will be tested at each jack according to TIA/EIA-568-B.2 for the following parameters:

   Wire Map
   Insertion Loss
   Cable Length
   NEXT Loss Pair-to-Pair
   NEXT Loss Power Sum
   ELFEXT Pair-to-Pair
   ELFEXT Power Sum
   Return Loss
   Propagation Delay
   Delay Skew
   Loop Resistance
   Impulse Noise
   Cable Length and Impedance (characterized by onboard Time Domain Reflectometer)
   Cable attenuation
   Cable near-end crosstalk

7. All test results observed according to the above-listed criteria will be printed on hard-copy and captured on computer disk file and the results (for line mapping, loop resistance, and impulse noise) will be used by the Contractor to determine any polarity and noise anomalies for immediate correction.
8. Test results for cable impedance, length, NEXT, will also be printed on hard-copy, or captured on computer disk file. These results will be used jointly by the Contractor and 4J to determine the viability of each sheath for midspeed LAN transmission in accordance with the specifications of the cable manufacturer, and the requirements imposed by the EIA-568 building wiring specification. This will form part of the acceptance procedure for the copper cable plant.
9. All hard-copy results obtained by use of pair-scanner testing will be collated by building and Telecommunications Outlet number, bound, and presented to the Architect at the conclusion of the testing for each building. Each individual test compilation for each building shall be initialed and dated by the Contractor's technician performing the test. The format of each test will be as shown in the Appendices – Horizontal Twisted Pair Test Results.

C. Defects
   1. When errors are found, the source of each error shall be determined and corrected and the cable retested.
   2. All defective components shall be replaced and retested following the procedure described above.

   3. A list shall be submitted for District approval of any defective components that the Contractor is unable to correct with a detailed explanation and alternative proposals.

D. Test Records
   1. Test records for cable shall be maintained using an organized format. The forms for twisted-pair and optical fiber cable shall record MDF/IDF Room number, backbone pair/strand number or outlet ID, outcome of test, re-test results after problem resolution, and signature of the technician completing the tests. Test results shall be submitted in electronic format. Sample forms are included in the Appendices of this document.

END OF SECTION

SECTION 27 41 16

INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing Basics: Drawings and general provisions of Contract, including Revised General Conditions, Special Conditions and other Division 01Specification sections apply to this section.

1.2 SUMMARY

A. Content: Various audio and video systems, equipment and installation includes, but is not limited to:

1. Gym, Cafeteria, Music Room and Media video and sound systems

B. BID ALTERNATE: Gym #1 AV system alternate is to provide and install AV equipment per drawings and specifications. Base bid includes infrastructure as shown on AV drawings.

C. Nomenclature: The systems shall be called the “sound system”, “audio/visual system”, “sound field system” and the installer the “AV system installer” or “AV contractor”.

D. Equipment:

1. Audio Mixers, Equalizers, Amplifiers, Program Sources, and other audio processing equipment.
2. Loudspeakers, custom coated enclosures and speaker mounting or support hardware including speaker mounting frames and incidental steel support members.
3. Video Projectors and associated routing and switching equipment.
4. Equipment Racks and portable cabinets.
5. Control Equipment, remote power switching
6. Cables, connectors, plates and wiring.

E. Related Sections: Division 01 and applicable Sections under Division 26.

1.3 REFERENCES:

A. Sound System Engineering (2nd Edition), Davis and Davis, Howard W Sams, 1987

B. Audio system – Design and Installation, Giddings, Howard W Sams, 1990

C. ANSI S4.48-1992

D. EIA Standard RS-160

E. EIA Standard RS-219

F. EIA Standard RS-460

1.4 SUBMITTALS

A. Comply with Section 01 33 00, unless otherwise indicated.

B. Provide simultaneously thirty (30) days after issuance of Notice to Proceed.

C. Complete schedule of submittals.

1. Chronological schedule: of Work in bar chart form (using Microsoft Project or similar program). Revise and resubmit schedule as required to reflect construction progress.

2. Product Data Sheets: Provide a list of products (with manufacturer's data sheets) on products to be incorporated within the Work. Arrange data sheets in specification order per system.

   a. Submit (3) three bound originals of manufacturers' product technical data for each product in sufficient detail to facilitate proper evaluation of product suitability for incorporation in the Work.

   b. Provide tab dividers for each group of data sheets, arrange each section in alphabetical order.

3. Shop Drawings:

   a. Shop drawings are to be prepared in the current version of AutoCAD and submitted 30 days after submittal sheets. Subsequent revisions and Project Record Drawings are also to be generated in the current version of AutoCAD. AutoCAD 2007 or later

   b. Installation: Special details depicting methods and means specific to each product, assembly and each product manufacturers recommended installation methods and means.

   c. Schematic: Detailed, redrawn wiring diagrams for each system, including cable types, identification and color codes, and detailed wiring of connections and terminal strips.

   d. Floor Plans: Drawn to scale of not less than 1/8" = 1'-0". Show AV Systems devices including wall and ceiling mounted speakers, wall and floor panels/plates, junction boxes, and terminal strip locations.

   e. Control: Detailed wiring diagrams including pin-outs and component lists Include color codes and cable types.

   f. Equipment: Location of Equipment in racks, consoles, tables, or cabinets, with dimensions. Wire routing and cabling within housings, AC power and terminal strip locations.

   g. Custom Enclosure and/or Millwork: Full fabrication details indicating size, material, finish, and openings for equipment.

   h. Speaker Mounting Details: Retain services of registered professional structural engineer, licensed to practice in the state of Oregon to review and develop mounting details. Structural information to include design calculations and copy of engineer's certification stamp. Loudspeaker location, orientation, and support systems shall be shown.

   i. Labeling: Include representative equipment and cabling labeling scheme.

   j. Include any other pertinent information generated which is necessary to provide the Work.

   k. Develop a test report form to be used during the Contractor's Testing Procedures described in Part 3. Submit this form for approval as part of submittal package 30 days after notice to proceed.

D. Submit three bound original sets of the following Project Record Manual information after substantial completion and prior to final inspection.

1. On the cover of the bound original provide the project name, year and month of substantial completion, name of contractor, address of contractor, phone number for obtaining service in the event of failure and the official end date of the system warranty.

2. Product Data: Product actually incorporated within the Work, including manufacturers' data sheet and owners manual for each product. Include a complete list of all equipment with serial numbers of all products.
3. Record Drawings: Final rendition of drawings depicting the actual installed system.
4. Test Reports, as described in the Test section and approved as part of the submittal documents.
5. System Operation and Instructions: Prepare a complete and typical procedure for the operation of the equipment as a system, organized by subsystem or activity.
6. Service and Maintenance Manual: Provide an original copy of the service manual on every piece of equipment for which the manufacturer offers such a manual. Include phone numbers and hours of operation for all manufacturers.
7. Warranty Manual: Include manufacturers warranty statements, date of substantial completion and ending dates for warranties for each type of product, plus any other pertinent data required for future maintenance.

E. Project/Site Conditions:
1. Verify All Conditions At Jobsite. Promptly report variations and obstructions to the AV Consultant. All additions or corrections are to be requested prior to fabrication.
2. Field measurements shall be taken by the AV Contractor prior to preparation of shop drawings to ensure proper fitting of work. Allow for adjustments during installation whenever taking field measurements.

1.5 QUALITY ASSURANCE

A. AV Contractor must be experienced in installation of systems with similar complexity as those required for this project. The AV Contractor must have at least five years experience with the equipment and systems specified, must install audio/visual systems as at least 80% of their overall business, and must be able to document relevant experience with projects of similar scope installed within the past five years.

B. Installers Qualifications: Any AV Contractor who wishes to bid must submit qualification information to the Architect and AV Consultant at least (14) fourteen days prior to the bid date. Proposal must include:
1. Names of individuals holding in excess of 33-1/3% of stock in the firm, and individuals, partnerships, or corporations with which the firm is affiliated in co-ventureships or joint ventures.
2. List of not less than 10 projects of similar size and scope completed within the past five years. AV Contractor shall indicate responsibilities (engineering, shop drawings, fabrication, etc.). Furnish recent contact name, address, and phone number for each project.
3. List of current projects and approximate contract value and completion dates. Include list of names, phone numbers and addressed of owner, owners representatives, and architect. Include list of personnel who are actively involved in the current projects.
4. Provide proof of bonding capacity for an amount equal to this project. Include list of other bonded projects coinciding with this project.
5. Evidence of ability to undertake custom product engineering to meet the specific requirements of the project specifications. Provide sample project engineering drawings for custom products and contact information for facility operators where those products have been installed.

6. Project Manager and Staff: the AV Contractor must provide the name, title, and resume of the project manager and assigned staff for the Project. The project manager shall not be changed without written consent of the Owner.
7. The AV Contractor must be a franchised dealer and authorized service center for the major products specified (or provide acceptable documentation as to how products will be acquired and serviced).

1.6 DELIVERY HANDLING AND STORAGE

A. Delivery: Deliver products in original unopened packaging with legible manufacturer's identification.

B. Storage and Protection: Comply with manufacturers recommendations. Store in a cool, dry place, out of direct sunlight, and protect from damage. Provide protective covering during installation to prevent damage from dust or other foreign materials. For products not currently installed provide secure locked storage both on site and at the AV Contractors own facility.

1.7 WARRANTY

A. In addition to manufacturers' warranties, the AV Contractor shall warrant all equipment to be free of defects in materials and workmanship for not less than one year after date of Substantial Completion. Defects occurring in labor or materials within the warranty period shall be rectified by replacement or repair within 24 hours (if parts require longer periods to obtain, provide substitute equipment during the intervening period). Provide response to service calls and requests for information within 24 hours.

B. AV Contractor to provide Owner with exact beginning and ending dates of the warranty period, include the name and phone of the contact person as well as the procedure for obtaining service.

C. Preventive Maintenance: At six months after system acceptance, and 30 days prior to the end of the warranty, provide a complete checkout of system components. Repair or replace defective equipment, and correct any wiring or functional problems reported by the Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Refer to Division 01.

B. Model numbers and manufacturers included in this specification are listed as a standard of quality. Other qualified manufacturer's products will be considered subject to submission and approval of complete technical data, samples and results of laboratory tests, in accordance with Division 01. Substitutions will only be accepted if, in the opinion of the AV Consultant, the product is an equal to the specified product. No substitutions may be made without written acceptance from the AV Consultant. All substitutions made prior to this acceptance are at the sole risk of the AV Contractor. Substitution requests need to be submitted no less that (14) fourteen days prior to the bid date.

C. See Attachment "A" for the specific equipment list for each area. The equipment list and drawings are representative of the design and do not necessarily provide all equipment and detail for a fully functioning system. It is the responsibility of the AV Contractor to ensure the system is complete and functions according to the system descriptions and design intent.

D. For bids to be considered complete and qualified they must be bid per the documents and specifications. If proposed system includes equipment other than that specified, submit a list of major items and quantities, with a one-line schematic diagram for review and approval. Include

a list of previously installed projects with similar equipment included. This list is to be submitted as an alternate to the actual bid document.

2.2 GENERAL

A. Provide new equipment and materials which conform with applicable UL, SCA, or ANSI provisions.

B. Regardless of the length or completeness of the product description in this specification, each device shall meet the published manufacturer's specifications. Verify performance as required.

C. Cable and Wire: The highest quality, lowest signal degradation cable and wire shall be used for the project. Shown below are typical cable and wire types. AV Contractor shall submit wire and cable types for approval prior to wire pull.

1. Microphone: (AM) Belden 9451

2. Line Level Audio: (AL) Belden 9451

3. Speaker Cable: (SL, SH, SZ) West Penn C210 (main speakers), West Penn 227 (monitor speakers), West Penn 225 (70.7 V Systems)

4. Control: (CG, CR) Belden 9455 (9 conductor control cable) Low Voltage AC power sequencing, (CS, CI) Belden 9451 Serial control cable.

D. Conduit: All cable and wire shall be run through EMT conduit. Separate conduits shall be used for video, line-level and microphone level audio, control, amplified audio to speakers, and network signals.

E. AC Power Sequencing and Distribution: Each equipment rack shall have power sequencing to supply power to each component in a sequenced manner. A power-on switch shall be provided at each rack. All AV equipment shall be supplied with transformer isolated AC power.

F. All equipment and components shall be new and complete. No used or reconditioned equipment shall be acceptable.

G. All mounting hardware shall be included.

H. All equipment and components shall be factory tested prior to shipping.

I. All bolts and fasteners must be Grade 5 or better.

J. All bolted attachments to have lock washers or other approved self-locking hardware.

K. All microprocessor controls shall utilize a non-volatile memory. System configuration, operating parameters, presets, etc. shall be protected against system power failure for a minimum of 48 hours.

L. All internal rack wiring shall be factory completed and clearly marked. All field connections shall be by connector, terminal strip or other device previously specified. Any terminal strip connections shall be clearly labeled as to terminal designation.

M. All wire sizes and insulation to comply with UL standards and local codes.

N. All wiring to be harnessed and bound. No loose or randomly routed wires shall be permitted.

O. No manufacturer logo shall appear on control station face plates or any other device located in public areas.

P. Any supplementary or auxiliary equipment necessary for the operation of the system shall be supplied with overload and short-circuit protection.

Q. Do not purchase or fabricate any materials, components or items to be used in the sound, video and communication systems prior to review of shop drawings, unless otherwise directed by AV Consultant.

R. Use only materials, components and items that conform with industry practice and applicable code standards. Use only components which are new and never previously used. Take care during installation to prevent scratches, dents, chips, etc.

S. Install all rack-mounted equipment with 10-32 button head machine screws with Phillips head.

T. Custom rack panels shall be 3/16" thick aluminum, standard EIA sizes, brushed black anodized finish unless otherwise noted. (Brush in direction of aluminum grain only.) Custom connector plates (loudspeaker, microphone, video, etc.) are typically stainless steel. It is the responsibility of the Contractor to verify plate finish with the AV Consultant. Plastic plates will not be accepted.

U. All engraving shall be 1/8" block unless noted otherwise. Except where noted to the contrary, on dark panels or pushbuttons, letters shall be white; on stainless steel or brushed natural aluminum plates, or light-colored pushbuttons, letters shall be black.

V. Connections shall be made with approved connectors and/or terminal blocks equal to Cinch 140 series or as indicated. Mount trim potentiometers, custom circuit cards, relays and transformers (except large 70V units) in shielded enclosures, and mark their function and connections with engraved lamacoid labels.

W. Per IEC-268 standard, all XLR connectors, within equipment or out, shall be wired pin 2 hot (high), pin 3 low, and pin 1 shield (screen).

X. Unless otherwise stated, all rack-mounted electronic and electrical equipment and components shall conform to EIA 19" standard. Any devices not specifically designed to be rack mountable shall be adapted, by professionally acceptable methods, to meet the EIA standard.

Y. The rack height of all equipment and components in this specification is in 1.75" (44mm) units denoted xU", i.e., a 5.25" device, which is three rack spaces high is denoted as "3U".

Z. All components shall be factory tested prior to shipping.

AA. All switches used in these systems (whether or not mentioned or shown in this specification) shall have sufficient voltage and amperage rating to cover the use for which they are required with a safety factor of at least 2. All switches handling audio circuits shall use gold contacts and shall meet JAN-S-23 or MIS-S-3950A specifications or equivalent. Used LED lighted switch to indicate on, off and preset conditions.

BB. Audio transformers shall be of appropriate impedance ratio and power handling capacity for the function intended and, unless otherwise noted herein, shall have a frequency response within +/- l dB from 20-20,000 Hz.

CC. All joints and connections shall be made with rosin-core solder or with mechanical connectors approved by the AV Consultant. Where spade lugs or other crimp-type terminals are used, crimp properly with ratchet type tool. Between racks, cabinets, consoles or modules, all cable shall terminate in approved terminal connectors, strips, blocks or boards.

DD. Route unbroken microphone audio line and control wiring from receptacle plate/chassis to rack. Remove spliced cables and replace without additional charge to Owner.

EE. No splices shall exist in any length of wire run except where noted on drawings.

FF. Connect all loudspeakers electrically in phase, using the same wire color code for loudspeaker wiring throughout the project.

GG. All wiring and connections shall be completely visible and labeled in rack. Termination resistors shall be 1/2 watt metal film 1 % tolerance; fully visible and not concealed within equipment or connectors.

HH. All terminations of shielded cables shall consist of a PVC or neoprene heat shrink sleeve covering the shield drain wire and an overall PVC or neoprene heat shrink sleeve covering the point at which the cable jacket and shield end.

II. Run vertical wiring inside rack in properly sized raceway with snap-on covers (Panduit type E series). Horizontal wiring in rack to be neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack but still allow for service and testing. Provide horizontal support bars for cable bundle sag. Neatly bundle excess AC power cable from rack-mounted equipment with plastic cable ties. Rack wiring to be bundled with plastic cable ties or lacing twine. Electrical tape and adhesive-backed cable tie anchors are not acceptable.

JJ. Audio Shielding /Grounding:

1. All shielded cables shall have their shields isolated from both the conduit system and any other shielded cables. Shields shall be continuous from source to input points. Shields shall be connected at input points only, with shields lifted at the source, except as noted below.
2. Microphone wiring shall have continuous shields from the microphone receptacle to microphone patch jack and if normalled to a console microphone input, continuous to that point.
3. Tie-line patch points shall have continuous shield connection from one patch jack to another with no permanent connection to the audio ground network.
4. Unbalanced wiring, such as used in certain communication systems, shall have audio shields connected at device inputs and floated at device outputs. Strap shield to "low" side of unbalanced input.
5. No "doubling up" of ground points on multi-pin connectors or terminal blocks shall be allowed.
6. Shielded audio cables that normal through patch panels shall utilize a normalling type jack which has an isolated switching "break" circuit. This shall be used for sleeve normalling.

KK. AC Power and Grounding:

1. Coordinate final connection of power and ground wiring to racks. Hard wire power wiring directly to power contactors or internal AC receptacles to ensure uninterrupted
2. Install approved isolated-ground receptacles in wireway in each rack. Provide a minimum of two spare outlets in each rack. Label each outlet as to which AC circuit is feeding it and provide the same information in the circuit breaker panel.
3. Install a copper ground buss bar top to bottom in each rack, insulated from the rack. Ground equipment chassis not having a three-wire power cord to these busses. Connect green ground wire from each AC outlet in rack to this bus bar.
4. AC power for the AV Systems is distributed at 120VAC, 60Hz, on the same electrical phase, building wide.
5. Isolated-Ground (Audio Ground) Distribution:
    a. The sound system "isolated ground", including ground source, ground conductors, and ground distribution points shall be installed by the Electrical Contractor. The isolation and ground continuity of this network, although the responsibility of the

Electrical Contractor, shall be reconfirmed by the AV Contractor prior to installation of equipment.

b. Except at the ground source, the audio ground shall be totally isolated from all other electrical grounds. Therefore, if the connection between the audio ground network and the ground source is disconnected, no continuity between the audio ground and the building electrical ground shall exist.

c. All equipment racks containing active electronics shall be connected to the audio ground, except as otherwise noted in this specification. Caution must be exercised so that these racks are not permanently, or in any way during operation, capable of being accidentally connected to the building safety ground.

d. All conduits and back boxes containing AVC Systems wiring shall be permanently connected to the building electrical safety ground.

e. Note: RF video devices, being unbalanced in nature, shall not be connected to the sound system audio ground network. Care shall be taken when intermixing such video and audio equipment.

LL. Electrical Safety:

1. No voltage in excess of 25V RMS AC or 24V ripple free DC shall be exposed to touch in normal use or in any equipment by the withdrawal of modules or of any plug or connector or without the removal of suitably indelibly labeled covers.

2. Unless specifically excepted, all live electrical parts above 50V RMS AC or 60V ripple free DC, including terminals, shall remain completely shrouded by insulation or grounded metal when the main access panels are removed. The separate shrouds or covers shall require a tool to remove them to prevent inadvertent contact with live parts.

3. In addition, where enclosures or items of equipment containing predominantly control, computer, or similar low voltage signals also contain voltages in excess of 50V RMS AC or 60V ripple free DC, clear standard warning notices indicating the maximum voltage present shall be provided on all removable access panels. Similar warning notices shall be provided where voltages exceeding 120V are present in any enclosure or item of equipment and such a voltage would not reasonably be expected to be present.

4. Within enclosures, racks and panels identify with prominent, standard, and indelible signage which circuit breakers or disconnects are to be switched off in order to isolate the equipment totally. Warning notices shall also be provided on all equipment which contains live terminals after operation of its circuit breaker or disconnect. These terminals must be completely shrouded to prevent inadvertent contact.

5. All equipment, control stations, equipment racks, enclosures, and all metal cases, raceways, and conduit shall be efficiently grounded. Special hand held or portable equipment which is not double insulated shall have duplicated grounding connections. All grounding shall be in accordance with the current edition of the National Electrical Code and as identified within this specification.

MM. Noise From Equipment

1. The residual noise and hum output of the systems shall be such that PNC-15 or below can be measured at the center of main floor, and the character of the remaining noise must be random, with no audible discrete frequency components.

2. Where a control panel or rack is to be used or located in an operational area, such as on the fly chamber, gallery, or control room, there shall be no acoustic noise associated with the panel. No internal cooling fans or similar moving or magnetic equipment shall be permitted unless approved by the AV Consultant in writing.

3. Operation of switches, pushbuttons, relays, solenoids, and similar shall not be audible to members of the audience.

2.3 GYM AND AUDITORIUM SOUND AND VIDEO SYSTEMS

A. System Description:

1. The gym and auditorium shall be provided with a sound system capable of picking up sound in the front area via microphones plugged in at the wall box and reinforcing it into the cafeteria. A fixed mix location shall be provided at the rear of the room.
2. An audio mixer shall be provided for production events. Monitor speakers shall also be provided on a single monitor channel.
3. An AV closet adjacent to the areas will store the AV equipment.
4. A switch for the screen will be located in the AV closet.
5. The mixer, CD player/iPod connection, wireless microphone receivers, monitor equalizer and a drawer for microphones shall be mounted in a portable rolling equipment rack capable of being connected and operated from the mix location or the AV closet.
6. Sound coverage shall be provided to the entire room area by two speakers mounted above the stage. The speakers shall be arrayed in such a manner as to provide seamless coverage of the intended areas. The speakers shall provide uniform sound levels of up to 98 dB (+/- 3 dB). Frequency response at every seat shall be +/- 1 dB from 50 Hz to 17 KHz. %ALCONS shall be 8% or less.
7. A fixed equipment rack shall house the amplifier and speaker processor.
8. A video projector shall project onto a large screen at the front of the room. The projector shall be front projection and the screen shall provide a suitable projection surface.
9. Video inputs for laptop and auxiliary video shall be located in the wall panels at the front and mix location, which will route to the AV closet.

2.4 LOUDSPEAKER ARRAYS – GENERAL REQUIREMENTS

A. Design and provide all required mounting brackets, hardware and components, safety systems and rigging systems using a minimum safety factor of 7:1.

B. Provide all integral redundancy components, such as safety cables, as required to meet these criteria.

C. Coordinate cluster weights and hang locations with Structural Engineer to ensure sufficient structural support.

2.5 EQUIPMENT RACKS AND ENCLOSURES

A. EIA 19" standard racks providing up to 44 rack units or as directed on the associated drawings of panel space (overall height: 83"),24.25" of width, and 22" of depth, minimum. This rack is supplied with rear door and adjustable front and rear mounting rails.

B. Provide interior switched incandescent work lamp for each rack.

C. Provide matching blank panels in all spare rack spaces. See "blank panels" section.

D. Provide matching 1 U ventilation panels above and below all power amplifiers, and additional vent panels as shown in rack elevation drawings.

E. Provide one (1) rack mount AC power receptacle strip for each rack group, with a minimum of one (1) 120V 20A duplex receptacle (NEMA 5-20R) for each individual rack (e.g., a group of three (3) racks requires a total of three (3) duplex receptacles). Receptacle strip shall mount to the front of one rack and be connected to an unswitched AC power circuit.

F. Provide heavy copper busbar in each rack for connection of isolated ground circuits. Bond busbars together with 3/0 A WG welding cable in a "star" configuration. Refer to AC power grounding detail on EE drawings for further information.

G. All racks shall have the same color finish (Textured Black).

H. All metal cabinets connected to the sound system audio ground shall be effectively isolated from any conduit or other metallic component that is connected to the building electrical safety ground.

2.6 AV RECEPTACLE PANELS AND NEMA WALL BOXES

A. Custom Fabrication: Single or multiple signal level and circuit receptacle panels shall be provided for connection of auditorium devices at designated locations in the facility. Panels may include any combination of circuits and connectors for these signal levels: microphone level, line level, video level, intercom level, and low volt/impedance loudspeaker level. Connectors shall be identified as to signal level, circuit type, and circuit number by clearly engraved and coordinated legends on each panel. Exceptions as noted. Refer to device plans for locations.

B. Refer to Systems Panel & Device Schedule (Electrical Drawings) for back box type, size, and depth, and mounting information.

C. Conduit and AV system back boxes shall be supplied and installed by others.

D. AV system panel covers shall be provided and installed by the AV Contractor, except as noted.

E. Wire shall be supplied, pulled, and terminated by the AV Contractor

F. Connector: Panel or chassis types, as indicated below. Mount on AV system panel as shown on drawings and fasten with stainless steel machine screws, hex nuts, and lock washers (screw head style, color, and thread size to match connector body; slot or Phillips drive to match wall plate screws). Refer to connector specification paragraph below. Exceptions as noted.
   Microphone level ("AM" series): Female XLR-3.
   Line level (“AL" series): Male & female XLR-3 pairs.
   Low volt/impedance loudspeaker ("SL, SH" series): NeutrikNL4 series.

G. Engraved Legend: Details as indicated below. Locate legends on AV system panel as shown on drawings. Characters shall be engraved, filled with colored enamel, and entire panel sealed. Exceptions as noted.

H. Legends shown on drawings are typical. Refer to AV systems block diagrams and/or submit proposed layout to AV Consultant for review.

I. Signal level title legend size shall be 0.1875" or 0.250" high characters of medium weight (as required).

J. Termination:
   1. XLR-type Connectors: Solder wire directly to connector in the field.
   2. Neutrik NL4 Series Connectors: Attach properly sized crimp-type female disconnect terminals to large gauge loudspeaker wire and mate with male disconnect terminals on the Neutrik connectors. Securely strain relief loudspeaker wires to connector body or wall plate to ensure integrity of the electrical/mechanical disconnect termination.

K. Wall Receptacle Plates (Sizes As Shown On Drawings And Schedules):
   1. All plates shall be flush type for mounting to recess back boxes or surface mount Wiremold-type boxes.

2. Wall Plate: Standard, x-gang (size "x" to match detail drawings), type 302 stainless steel (heavy gauge), bright brushed or satin finish, flush-type electrical wall plate. Mount to back box with 6-32 stainless steel, slot or Phillips drive, oval head machine screws.
3. Plates in public areas to have finish by Architect.
4. AV Panels (Sizes As Shown On Drawings And Schedules): Fabricated of type 5052-H32 aluminum, 0.125" minimum thickness, lightly brushed (vertical direction), with black anodized and clear sealed finish. Panel dimensions to match back box size. Edges of panel shall be ground square and flat. Comers of panel to have small radius. Exceptions as noted below.
5. Back Box: Provided by others, Hoffman type with a minimum depth of 6". Color: Black. Exceptions as noted below. Coordinate with Electrical Contractor.

L. Audio Connectors

1. XLR-3 (Microphone, Line; Communication): Neutrik NC3MD-L-l (male) and NC3FD-L-l (female) panel mount connectors; Neutrik NC3MX (male) and NC3FX (female) cable connectors. Silver contacts and nickel shells throughout. Balanced mic/line: pin 1 shield, pin 2 hot, pin 3 low. Unbalanced mic/line: pin 1 shield, pin 2 hot, pin 3 tie to pin 1. Production Intercom: pin 1 shield, pin 2: +30VDC, pin 3 audio/signal.
2. In no case shall pin 1 be tied to case of connector.
3. XLR-4 (Production Intercom Headset/Handset): Neutrik NC4MC (male) and NC4FC (female) cable connectors. Silver contacts and nickel shells throughout.
4. NL4 Type (Loudspeaker): Neutrik Speakon NL4MP panel mount connector; NL4MPR sealed loudspeaker cabinet chassis connector; and NL4FC cable connector.
5. 1/4" Phone Plugs and Jacks: Plug: Neutrik NP2C 2-pole and NP3C 3-pole cable plugs. Nickel contacts and nickel shells. Jack: Neutrik NJ3FC6C latching 2- or 3-pole cable jack. Silver contacts and nickel shells. 3-pole: Sleeve = ground/shield, ring = low, tip = high (hot). 2-pole: Sleeve = common/ground/shield, tip = high.
6. 1/8" Mini Plug: 1/8" T/R/S "Walkman-type" stereo mini plug. Metal shell required, Phono (RCA) plugs and jacks. Plug: Neutrik ProFi NF2C/2 RCA plug (available in pairs of black and red). Gold plated nickel contacts and brass shell. Jack: Switchcraft 3503 RCA cable jack. Nickel plated brass contacts and shell.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate work with other trades to avoid causing delays in construction schedule

B. Mount equipment and enclosures plumb and square. Permanently installed equipment to be firmly and safely held in place, with equipment supports having safety factor of 7 for speaker mounts and 3 for all other equipment

C. Cover edges of cable pass-through holes in chassis, racks, boxes, etc, with rubber grommets or Brady GRNY nylon grommet material.

D. Speakers mounted in acoustical tile ceilings must be properly supported with tile bridges or similar structural bracing.

E. System Wiring: Take precautions to prevent and guard against electromagnetic and electrostatic interference (hum and buzz). Check AC power and grounding prior to AV system installation, and report any issues promptly.

F. Equipment and Cable Labeling: Provide engraved lamicoid labels on front and rear of active equipment mounted in racks. Include name of device, reference to drawing name, and other areas the device feeds or controls. Label cables in a consistent manner, with permanent, heat-shrunk labels. Show all equipment designations in Permanent Record Drawings.

3.2 INITIAL TESTS AND ADJUSTMENTS

A. Preliminary: Verify the following before beginning actual tests and adjustments on the system:

1. All electronic devices are properly grounded.
2. All powered devices have AC power from the proper circuit. Verify all dedicated AC power circuits are properly wired, phased, and grounded.
3. Insulation and shrink tubing are present where required.
4. Dust, debris, solder splatter, etc. is removed.
5. All cable is dressed, routed, and labeled; all connections are properly made and consistent with regard to polarity.

B. Grounding System Tests:

1. Measure the DC resistance between the technical ground in any equipment rack or console and the main building ground. Resistance should be 0.15 ohms or less.
2. Temporarily lift the technical ground from the main electrical ground, and measure the DC resistance between them. Resistance should be at least 1 Megohm.
3. Verify the electrical contractor has connected the technical ground to building ground at only one location with 1/0 or larger wire.
4. Measure the DC resistance between the signal ground at any interface plate and the conduit system.
5. Identify and correct any problems if within the Audio system scope of work; notify the General Integrator if problem is in a related area of work.

C. Audio System Tests: Perform the following tests and adjustments, supplying all test equipment required. Follow EIA Standards RS160 and RS219 in performing tests. Make all corrections necessary to bring system(s) into compliance with the specifications. Design goals for the system have been calculated in accordance with accepted industry standards. Actual performance may deviate slightly due to component variations, field conditions or limitations, and building interaction. Design parameters are: system frequency response shall be +/- 3dB 50 Hz -16 kHz. Evenness of coverage shall be +/- 3dB maximum at 2 kHz throughout listening area. Nominal sound pressure level shall be 95 dBA SPL at any seat in the auditorium area with a maximum continuous SPL capability of 105 dBA.

1. Measure and record the impedance of each speaker line circuit terminating at the equipment rack, with speakers connected, employing frequencies of 125, 500, 1000 Hz, and 4000 Hz and others as appropriate to the driver (use all for full range systems).
2. Adjust the gain of each active device to provide optimum signal-to-noise ratio and 18 to 20 dB headroom. Record input and output levels at each step in the signal chain.
3. Measure and record overall system hum and noise level of each mic or line amplifier with controls set so that -50 dBu microphone input or +4 dBu line level input would drive the system to full amplifier output. Terminate inputs with appropriately sized shielded resistors (150 ohms typ) for this test.
4. Measure and record electrical distortion of each input through amplifiers, switching, and power amplifier for each system installed; distortion should be less than 0.5% for the overall system in each test. Observe the output waveform on an oscilloscope for freedom from clipping, parasitics, oscillation, or RF components which could indicate unacceptable system operation.

5. Measure and record system electrical frequency response for each input channel through power amplifier output. Deviation shall not exceed +1 dB within the range 30 to 18,000 Hz.
6. Check system to assure freedom from oscillation or stray RF pickup. Check all inputs without signal and with 1000 Hz sinewave driving system to full output. Detect unwanted signals on oscilloscope at rack termination and over single loudspeakers connected at the farthest distance from the rack for each loudspeaker line.
7. Measure and record the output impedance of each active device operating as a source to a passive device or network. Measure and record the input impedance of each active device used to terminate passive devices.
8. Check polarity of all loudspeakers with an electronic polarity checker and by applying music program or pink noise signal to system while walking through the transition areas of coverage from one loudspeaker to the next. Transition should be smooth with no apparent shift in source from one speaker to the next.
9. Apply sinewave sweep signal to each loudspeaker system, sweeping from 50 to 5000 Hz at a level 10 dB below full amplifier output, and listen for rattles or objectionable noise.

D. Report: Upon completion of initial tests and adjustments, submit written report of tests to Owner along with all documents, diagrams, and record drawings required herein. Report shall include date of each test, pertinent conditions such as control settings, etc., test circuit, and test equipment employed. In addition, submit written notification that the installation has been completed in accordance with the requirements of the Contract Documents, and is ready for acceptance testing.

3.3 TEST EQUIPMENT

A. Provide the following test equipment on site and available to the Owner during acceptance testing. Provide and use only new test tapes for this project.
1. Tools including screwdrivers, pliers, cutters, wire strippers, nut drivers, crimpers, heat shrink blower, controlled temperature soldering unit, ladders, flashlight, measuring tape, electric drill, etc.
2. Sine Wave Generator. Output: +4 dBu, 5 Hz to 50,000 Hz with less than 0.05% THD into any load. Acceptable: Audio Precision, Hewlett Packard, Sound Technology, or Tektronix.
3. Pink Noise Source. Equal energy per octave bandwidth 20 - 20,000 Hz, +1 dB (long-term average) @ 0 dBu output. Stability: +2 dB per day. Acceptable: Ivie IE-20.
4. Impedance Meter. Capable of testing audio lines at three frequencies, minimum, between 250 Hz and 4000 Hz. Measurement Range: 1 ohm to 100,000 ohms. Acceptable: Sennheiser ZP-3.
5. Multimeter. Measurement range, DC to 20,000 Hz, 100 mV to 300 V, 10 ma to 10A. Acceptable: Fluke 77.
6. Real Time: 1/3 Octave Audio Spectrum Analyzer. Acceptable: Ivie IE-30A or equal.
7. Harmonic Distortion Analyzer: Acceptable: Audio Precision, Sound Technology, or Hewlett Packard.
8. Sound Level meter meeting ANSI SI.4 1971 Type 2. Acceptable: GenRad 1933 or B&K.
9. Dual-trace oscilloscope: 100 MHz bandwidth, 1 mV/cm sensitivity. Acceptable: Tektronix 2445.

B. Turn over Test digital data to Owner for maintenance upon completion of Acceptance Testing.

3.4 ACCEPTANCE

A. Acceptance testing will include operation of each major system and any other components deemed necessary. AV Contractor will assist in this testing and provide the test equipment specified herein. AV Contractor shall provide at least one technician available for the entire adjustment and testing period (day and night), to assist in tests, adjustments, and final modifications. All tools and material required to make any necessary repairs, corrections, or adjustments shall be furnished by the AV Contractor.

B. The Owner will physically inspect the system to ensure all equipment is installed in a neat and professional manner and as required by the contract documents. An inventory will be made of all equipment.

C. The following procedures will be performed on the System:

1. Adjust, balance, and align all equipment for optimum performance and to meet all manufacturers' published specifications. Settings to be reviewed include gain, delay times, and nominal settings. Establish and mark normal settings for all level controls, and record these settings in the System Reference Manual.
2. Check all control functions for proper operation, from all controlling devices to all controlled devices.
3. The audio fidelity test will consist of driving the speaker system with pink noise and measuring the response in each 1/3 octave band from 50 to 16,000 Hz. Equalization as specified shall be used to adjust the response as necessary to fit the requirements of the space.
4. Any other test on any piece of equipment or system the Owner deems appropriate.

D. In the event the need for further adjustment or work becomes evident during acceptance testing, the AV Contractor will continue his work until the system is acceptable at no addition to the contract price. If approval is delayed because of defective equipment, or failure of equipment or installation to meet the requirements of these specifications, the AV Contractor will pay for additional time and expenses of the AV Consultant at the AV Consultant's standard rate in effect at that time, during any extension of the acceptance testing period.

3.5 INSTRUCTION OF OWNER PERSONNEL

A. Provide 8 hours of instruction to the Owner's designated personnel on the use and operation of each of the systems. The instructor must be fully knowledgeable of all system functions and all equipment features. The System Reference Manuals shall be complete and on-site at the time of instruction. The AV Contractor shall be present at the first two formal uses of the system.

ATTACHMENT A: EQUIPMENT LIST

Note: this equipment list specifies major systems components and equipment, and may not detail all equipment required for a complete working system.

System	Sub-System	Manufacturer	Model Num.	QTY
Gym Audio				
Speakers	Main Speakers	JBL Professional	AM6215/95	4
	Stage Monitors	JBL Professional	MRX512M	2
Amplifiers	Main Speaker Amplifiers	Crown Audio	CTS-8200	1
	Monitor Amplifier	Crown Audio	CTS-1200	1
Console	16 Channel Mixer	Mackie	CR 1604	1
	Volume / Select Control	Biamp	Volume/Select 8	2
Sources	CD/iPod	Denon	500c	1
Processing	DSP	Biamp	Audia Flex	1
	Processor Input Card	Biamp	IP-2	4
	Processor Output Card	Biamp	OP-2E	2
Microphones	Wireless Receiver	Audio Technica	ATW-2110	2
	Wireless Microphone Element	Audio Technica	AT892-cW	2
	Handheld Microphone	Shure	SM-58LC	6
	Assistive Listening Transmitter	Listen Tech	LT-800-072	2
	Antenna	Listen Tech	LA-123	2
	Digital Receivers	Listen Tech	LR300-072	10
	Single Ear Phone	Listen Tech	LA-161	10
	ADA Signage Kit	Listen Tech	LA-304	2
Racks	Amplifier Rack	Lowell	L267	1
	Portable	SKB	Gig Rig	1
	Power Strip Relay Ctrl	Lowell	RPC-1-20A-CD	4
	Power Sequencer	Lowell	SCS-4R	1
	Custom Panel			5
Rigging				
Cable				
Misc				
Gym Video				
Projector		NEC	8000 Lumen	1
Projector Mount	Wall Mount (Behind Screen)	Chief		2
Projector Mount	Mount Adapter	Chief		2
Projector Mount		Chief		2
Sources	Bluray player	Sony	BDP	1
Scaler/Switcher		Extron		1
PC interface	rack mount	EXTRON		3
Screen	Dual View, electric	Da-Lite		1
Video Control		Extron		1
Projector HDMI interface		Extron		2
Custom Plate (Stage Floor)	with cover and pour box	FSR	FL600	3
Cabling				

Music Room

Speakers	Main	JBL Pro	LSR4328P	2
Speaker Mounts	Main	Omnimount	60 lb.	2
Rack Mixer		Rane	MLM 82S	1
Sources	CD Player/Recorder	Tascam		1
	iPod input	10' Cable + adapter		1
Processing		DBX Pro	220i	1
Rack		Lowell	L258-36	1
Equipment Rack Top		Lowell	L258-CT	1
Equip Rack		Lowell	Blanks, Drawer, Vent	1
Cable		Belden		1
Misc. pins, connectors, etc.				1
Labor				1

Cafeteria Audio

Speakers	Main Speakers	JBL Professional	AM6215/95	2
Amplifiers (part of gym system)	Main Speaker Amplifiers	Crown Audio	CTS-8200	0
	Monitor Amplifier	Crown Audio	CTS-1200	0
Console	16 Channel Mixer	Mackie	CR 1604	1
	Volume / Select Control	Biamp	Volume/Select 8	2
Sources	CD/iPod	Denon	500c	1
Processing (part of gym system)	DSP	Biamp	Audia Flex	0
Microphones	Wireless Receiver	Audio Technica	ATW-2110	1
	Wireless Microphone Element	Audio Technica	AT892-cW	1
	Handheld Microphone	Shure	SM-58LC	2
	Assistive Listening Transmitter	Listen Tech	LT-800-072	1
	Antenna	Listen Tech	LA-123	1
	Digital Receivers	Listen Tech	LR300-072	10
	Single Ear Phone	Listen Tech	LA-161	10
	ADA Signage Kit	Listen Tech	LA-304	1
Racks (part of gym system)	Amplifier Rack	Lowell	L267	0
	Portable	SKB	Gig Rig	1
	Custom Panel			1
Rigging				
Cable				
Misc				

Cafeteria Video

Projector		NEC	4000 Lumen	1
Projector Mount	Rear Wall Mount	Chief		1
Projector Mount	Mount Adapter	Chief	VCM-XXX	1
Sources	Bluray player	Sony	BDP	1
Scaler/Switcher		Extron		1
PC interface	rack mount	EXTRON		2
Screen	front projection, electric	Da-Lite		1

Video Control		Extron		1
Projector HDMI interface		Extron		1
Cabling				1
Media Video				
Projector (project on wall)		NEC	4000 Lumen	1
Projector Mount	Rear Wall Mount	Chief		2
Projector Mount	Mount Adapter	Chief		1
Projector Mount		Chief		1
	Projector Mount	Chief		1
Sources	Bluray player	Sony	BDP	1
PC interface HDMI EXTENDER	rack mount	EXTRON		1
Video Control		Extron	MLC 226IP	1
Projector HDMI interface		Extron		1
Custom Plate floor		FSR	8" poke through	1
Cabling				

[END OF SECTION]

SECTION 27 5113

INTERCOMMUNICATION (INTERCOM) SYSTEM

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish and install complete and operating addition to the existing system.

B. Furnish and install all required equipment necessary to interconnect the equipment to the existing intercom system.

1.02 DESCRIPTION OF SYSTEM

A. System provides ALL CALL and zone paging throughout the building, operated by picking up a telephone with this class of service and dialing an access code.

B. When not being used for paging, system serves as a distribution system for background music.

C. Selected offices are equipped with volume controls for individual preference. However, when in the OFF position, paging announcements will come through with normal, preset volume.

D. Hearing Assistance Systems

a. Radio-frequency, wireless hearing assistance sound systems shall be provided. These systems shall be capable of transmitting a signal which originates at the sound system signal chain.

1.02 QUALITY CONTROL

A. AMX SchoolView system shall be accepted for both paging and wireless master clock systems as a complete package. Refer to 27 5116.

PART 2 PRODUCTS

2.01 FLUSH SPEAKER, STANDARD

A. Backbox: Soundolier #95-8.

B. Speaker:

1. 8-inch, 5 watts normal power rating.
2. Full frequency response for music.
3. Integral Transformer: Dual voltage 25/70 volt line input, 1/4, 1/2, 1, and 2 watt output taps.
4. Compatible with existing system intercom master.

C. Baffle:

1. Round, flat, heavy gauge steel.
2. Finish: White enamel.
3. Soundolier #51-8.

2.02 VOLUME CONTROL

A. Priority attenuator type, stainless steel wall plate for single-gang outlet.

B. Outlet:

1. Box: 4-inch square, 1-1/2 inch deep, single-gang plater ring, flush in wall.
2. Conduit: 1/2-inch EMT to accessible ceiling.

3. Volume controls located at speaker, in ceiling space, require only a box.

2.04 SOUND REINFORCEMENT SYSTEMS

A. Every classroom will receive a sound reinforcement system. Units will be LightSPEED CAT 855IR, or AMX ResQ equivalent. All systems will include paging override option.
   1. Provide ceiling mounted IR sensors at the rate of one per 1000 sq/ft or smaller classrooms and at the rate of two per 1001 sq/ft or larger room.
   2. Ceiling mounted speakers per plans, Lightspeed DRQ or approved.
   3. Include power supply, and cables for sensors and speakers.
   4. Provide two REDMIKE volume control lanyard microphones with batteries, charger, and Page First Option.
   5. Provide stereo RCA connections between the projector and the sound reinforcement system.

2.05 WIRING

A. No. 22 AWG, solid, color coded pairs, overall PVC jacket.

B. Mohawk #1403 (3-pair) or Equal:
   1. One Pair: To volume and speaker.
   2. One Pair: To volume and speaker.
   3. One Pair: Spare.

PART 3 EXECUTION

3.01 INSTALLATION

A. Rough-In and Wiring Pulling: Requirements shall be coordinated with installer.

B. Equipment Installation: Shall be made by trained manufacturer's representative.

C. Fastening and Support:
   1. All equipment, except portable equipment shall be held firmly in place including loudspeakers, amplifiers and cable.
   2. Adequate to support their loads with a safety factor of at least three (3).

3.02 WIRING

A. Provide wiring as required by manufacturer for number of stations and arrangement shown.

B. Circuits, home runs, and feeders shown on Drawings are to establish routing and general system connection only. Provide number and type of wires as recommended by manufacturer.

3.03 TESTING AND ADJUSTMENT

A. Test each circuit after installation for quality of operation.

B. Set speaker transformer taps for proper sound volume, assuming a normal room ambient noise level.

END OF SECTION

SECTION 27 5116
INTEGRATED AUDIO-VIDEO SYSTEMS

PART 1 – GENERAL

1.01 WORK INCLUDED

A. The work described by this section includes the furnishing of all components, materials, equipment, installation and technical labor and the performance of all operations necessary for the complete installation of a Unified Campus System in operating condition as indicated on the drawings and/or specified herein.

1. Included in the Scope of this Section:
   a) Licenses, permits as may be applicable
   b) Provision of submittal information
   c) Installation in accordance with contract documents, manufacturers' recommendations and applicable codes
   d) Configuration of control and signal processing software
   e) Testing and adjustments, including documentation thereof
   f) Provision of manuals
   g) Maintenance and warranty services
2. Applicable References:
   a) National Electric Code (NEC)
   b) Underwriters Laboratories (UL)
   c) Telecommunications Distribution Methods Manual (TDMM)

B. In general, the conduit and/or cable tray, junction boxes, electrical power circuits and outlets and terminal cabinets, as required for a complete operating system, shall be furnished and installed by the Electrical Contractor. The entire responsibility for the system, its installation, operation and function shall be that of THIS Contractor.

C. The equipment shown on the Contract Drawings is to indicate the minimum system required, but may not show all of the required components or wiring. It is the responsibility of the Contractor to provide a complete integrated audio-video and communications system as needed to meet all applicable requirements under this section

D. Raceway, routing, and wiring for the devices are not shown.

1.02 DESCRIPTION

A. Project Summary for consistent bidding purposes:

1. System Type: Unified Campus
2. System Mode: Intercom
3. Admin Paging: 1 Gooseneck Mic
4. Classroom / Zone Count: as per Drawings
5. Classroom Input Count and Type: (1) VGA ,(1) HDMI and (1) IP Video
6. Common Audio Zone Count: as per Drawings, e.g. Hallways, Outside, Offices, Cafeteria, etc.
7. Emergency Notification: Video and Audio
8. Digital Signage Displays: as per Drawings
9. Additional Admin User Interfaces

(1) Wall Mount TP – Provide 3

(2) iPad using TPControl app

10. Background Music Sources

(1) AM/FM/Network Radio/iPod Dock

(2) CD Player / Changer

11. Telephone Interface

(1) Enhanced

12. Energy Management Options (Contact Closures)

(a) HVAC

(b) Lighting

13. Building Management System Interface (Contact Closures)

(a) Access Control

(b) Fire Control

(c) Security

B. This system shall consist of:

1. 1 administration control center location
2. 2 common area control centers
3. Classroom control panels as noted on plans
4. Classroom ceiling enclosures as noted on plans
5. Classroom AV switches as required
6. Classroom 27” display with integrated camera as noted on plans
7. Headend audio distribution system
8. Headend video distribution system

C. Each of these system components is described below. The audio rack shall contain the master control system in which the Integrated Audio-Video System software is to be installed. This rack location shall be dedicated to managing campus clocks, bells, PA/Intercom, remote microphones, telephone interfaces, background music sources, common zone audio and audio extractor for video sources.

1. System Includes:

a) Software

b) Admin Touch Panels

c) Bell System

d) Digital Clock Control

e) Audio Paging

f) Background Music

g) 2-Way Intercom Option

h) Remote Audio

i) Teacher’s Web Interface

j) Video Broadcast (DVD, Satellite, Cable, Digital Signage, video intercom)

k) Digital Signage

l) Emergency Alerts

m) Security Camera Interface

n) Lighting and HVAC systems interface

o) Microphones

p) Equipment cabinet

q) Analog Telephone Paging Interface

r) Bell & Alert Tones

s) Admin Monitor Speaker

t) Loudspeakers

u) Conductors and cables.

v) All material and/or equipment necessary for proper operation of the system, not specified or described herein, shall be deemed part of these specifications.

D. Quality Assurance

1. Installation shall be in compliance with the National Electric Code and all other applicable codes.
2. All equipment described herein or otherwise required to perform the specified system functions shall be a regular product line, produced by the system manufacturer.
3. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

E. Contractor Qualifications

1. The Unified Campus equipment package shall be furnished and installed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the Unified Campus contractor to utilize a sub-contractor for any portion of the work, unless the Subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.
2. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.
3. The Contractor shall employ factory-trained service personnel for the installation, service and maintenance of the system.
4. A statement of contractor's qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.
5. The names of at least two technicians who have or will complete factory Installation Training prior to start of project must be included with the submittals.

F. Shop Drawings

1. A complete and comprehensive list of materials with quantity, manufacturer, model and part number and reference to the Part 2 specification paragraph number for each item.
2. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.
   a) Drawings shall include designations, dimensions, operating controls, electrical requirements, input/outlet configurations, operating controls, etc.
   b) Major components including all sub-assembly components (daughter cards, option cards, etc.) required to perform the specified functions.
   c) Any items of equipment which have features and/or functions that deviate from the specifications contained herein shall have these deviations clearly called out by a separate attachment with the shop drawings specifically listing and detailing the deviation along with a justification. Deviations must be approved specifically in writing.

G. Job specific diagrams

1. This indicates a block schematic diagram that shows all major items of equipment required for the contract project and the actual interconnection that will be installed.

2. Riser diagram showing conduit requirements with pull boxes, outlet boxes, part numbers of cable used, and a number of circuits in each conduit. 3. Electrical power requirements for the head-end and ancillary equipment. Include diagrams for any remote control of electrical power, in sufficient detail to coordinate with electrical work. Electrical diagrams shall also indicate all required plug and power outlet configurations including where direct connection is required/preferred.

4. Schematic and point-to-point wiring diagrams showing all devices and wiring.

5. Identify terminals to facilitate installation, operation, and maintenance.

6. Single-line diagram showing interconnection of components.

7. Cabling diagram showing cable routing.

8. Details of interconnection with other systems

9. Supplier shall provide rack elevations showing the configuration of all rack mounted equipment including detailed interconnection diagrams between equipment

10. 30x42 floor plans at a scale of not less than 1/8"=1'-0" showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type. mounting height, etc.)

11. Proposed construction details for all custom fabricated items, including wall plates, interface panels, mounting hardware and systems, and rigging hardware. These details shall show labeling, dimensions and indicate finishes and color selection.

12. Power calculations for sizing Owner Furnished Contractor Installed UPS system.

13. Submittals that do not contain all the required information will be REJECTED unless prior approval for partial submittals has been approved.

PART 2 - PRODUCTS

2.01 PRODUCT EQUIVALENCY

A. Approved Product AMX Schoolview, Unified Campus

1. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.

2. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

3. Provide all required licenses for Unified Campus and related components.

B. Functional Description of System

1. Bell System Functions:

a) Software shall control and broadcast all bell tones over IP. Bell tones shall be stored as standard MP3 files and as such may be any type of audio tone, including but not limited to, bell tones, music files in part or full, recorded voice announcements, coded audio messages, or audible alerts. All MP3 files shall be directly selectable by the touch panel and web interface.

b) MP3 files shall be stored on an easily changeable USB flash drive.

c) The system shall support practically unlimited combinations of rooms and common areas to be saved as named zones with multiple automated schedules. Software shall provide the ability to create and maintain the bell schedules graphically on a rolling 12-month calendar.

d) Events shall be triggered by schedule or manual button on the touch panel.

e) A voice-prompted menu shall provide system administration functions via telephone. This option is referred to as “Enhanced Telephone Interface”.

2. Digital Clocks

a) Software shall control all connected digital clocks on campus. All clocks shall be RS-232 controllable and synchronized with the bell system. System time shall be capable of synchronizing to a network timeserver. The system shall provide an internal clock if network time information is not available

C. Audio Paging

1. Software shall control encoding and broadcast of live voice announcements via IP to any and all classrooms and common areas. The system shall provide practically unlimited combinations of rooms and common areas to be saved as named zones. Assignment of zones shall be chosen via a graphical floor plan image of the school. Audio paging is available from, but not limited to, the following:

2. Software shall control encoding and broadcast of live voice announcements via IP to any and all classrooms and common areas. The system shall provide practically unlimited combinations of rooms and common areas to be saved as named zones. Assignment of zones shall be chosen via a graphical floor plan image of the school. Audio paging is available from, but not limited to, the following:

3. Wall mounted microphone 1 per Admin Touch Panel

4. Push-to-talk / Remote microphones

5. Desktop telephone

6. Wireless / Cellular phone

7. Stand-alone sound system

8. Two-Way IP Intercom

a) Software shall be capable of supporting 2-way communication via the network between classrooms & predetermined locations such as a principal’s office, administration, or library.

b) The 1-way components must support a 2-way upgrade without hardware replacement. Additional encoder license and microphone may be required to deliver this functionality.

c) Events shall mute local audio sources in selected classrooms for the duration of the event and subsequently return local audio sources to the previously selected level.

D. Background Music

1. Software shall support the encoding and broadcast of Owner Furnished Equipment for MP3 or other portable audio sources to any combination of classrooms and common areas via direct IP audio streaming.

2. The Unified Campus System shall support virtually any RS-232 or IR controllable music source with published protocols including AM/FM Tuner, CD Player and / or Internet Radio.

3. The system shall provide practically unlimited combinations of rooms and common areas to be saved as named zones.
4. Events shall mute local audio sources in selected classrooms for the duration of the event and subsequently return local audio sources to the previously selected level.

F. Classroom Speaker Controls
1. Software shall provide direct network management of classroom speaker zones as a group. Individual Classroom volume control for Unified Campus is adjustable by the Unified Campus Contractor via audio decoder settings or optional external amplifier.

G. Remote Audio
1. Virtually any properly configured network data drop shall function as an input point to the system. The system shall allow the remote audio source to be defined as either a standard or priority audio event. As a standard audio event, the event shall not interrupt normal PA or bell events. As a priority event, the event shall interrupt all other audio events. Remote audio inputs shall support the following input types:
2. Microphones: The software shall support additional microphones to be connected to any network location via an audio encoding device. This device shall allow for any network jack to operate as a microphone input to the Unified Campus System.
3. Stand-Alone Sound Systems: The software shall support 2-Way audio from a stand-alone sound system such as a Gym, Lecture room, Cafeteria or Students lounge.
   a) The system shall allow for the audio from the location to be routed to any and all zones within the Unified Campus System.
   b) The system shall support local start / end of the broadcast event from the Stand-Alone Sound System. Administration location support shall not be required.
   c) The system shall also allow for the stand-alone sound system to receive any PA, bell, or background music event from the Unified Campus System.

H. Security Camera Interface
1. The software package shall allow interface of 3rd party IP based H.264 security cameras to display selected cameras on the touch panel's security page. This security page will provide for full screen view or quad views of selected cameras. The Unified Campus System software shall also provide pan/tilt/zoom/focus controls for any camera that supports such functions and allows network control. Supported Motion JPEG cameras:
   a) Axis
   b) Panasonic
   c) Sony
   d) Toshiba
   e) Samsung
   f) Arecont AV3105
   g) Pelco Sarix
2. Verification or Coordinated Testing of selected camera system is recommended.
3. The system shall support external (3rd party) contact closure associated with a specific camera location. The contact closure can be configured to trigger an audible tone and/or to display the associated camera to full screen on the touch panel. An "answer door" or "release door" button can provide contact closure to

3rd party access control systems to allow entry.

I. Classroom Control

1. The Unified Campus System shall provide control of the following devices / features:
    a) local classroom display
    b) AV switcher/audio amplifier
    c) video decoder
2. Controls shall be available via Teacher Client by default plus the 8-button control keypad method listed below. The Teacher Client shall be accessible as an application or via an Internet web browser such as Internet Explorer, Safari, Chrome and Firefox.
3. Classroom control methods include:
    a) 8-button Keypad
4. All classroom controls must communicate with the Unified Campus System.
5. Classroom display must support RS232 control with a published protocol for the following functions:
    a) Discrete Power On
    b) Discrete Power Off
    c) Discrete Input Select (VGA, Component, HDMI, Composite)
6. Specific classroom functionality shall include, but not be limited to, the following:
    a) Projector controls
    b) Room volume / mute
    c) Local source select
    d) Headend source (Campus Video) select with controls
    e) Favorite Channel
    f) Intercom control
    g) Energy management
    h) Tools

J. Video Broadcasting

1. The software package shall direct any and all classroom and common area flat panel systems to decode IP multicast video streams generated by third party MPEG-2 or h.264 video encoders (Visionary Solutions or APPROVED substitutions). The system shall provide practically unlimited number of combinations of rooms and common areas to be configurable zones and assigned to standard video sources such as, but not limited to, the following:
    a) DVD players
    b) Cable converter boxes
    c) Satellite receivers
2. The user shall be able to control each source from the admin touch panel, teacher's web client or graphical touch interface. Preview of the video shall be available directly on the Admin touch panel or through use of VideoLan's VLC video player on any connected PC or MAC. A video preview window shall be embedded within the teacher web client. Basic IR controls shall consist of but not be limited to navigation and transport controls.

K. Remote Video Broadcasting

1. The software package shall direct any and all classroom and common area flat panel systems to decode IP multicast video streams generated by third party MPEG-2 or h.264 video encoders, Visionary Solutions or approved substitutions.

L. Manage Displays

1. The software package shall provide network control and management of all classroom projectors. This shall include definition of auto-off times, display of lamp hours, current power status, monitoring for projector health and/or anti-theft alarms. Multiple auto-off time configurations must be available and programmable for multiple zones. The system shall support practically unlimited combinations of rooms and common areas to be saved as named zones. Named zones, groups of rooms or individual rooms shall also be controllable via a direct control interface. Control functions shall include, but not be limited to, the following:
   a) Power
   b) Input Select
   c) Favorite Channels
   d) Default Channel
   e) Campus Video
   f) Campus Audio

M. Digital Signage

1. The software package shall include a single (1) AMX Inspired Signage Xpress player to stream owner-created content to each display via multicast video encoder. The system shall support practically unlimited combinations of rooms and common areas to be saved as named zones. The system shall control all displays for auto-on and auto-off times. Named zones, groups of rooms or individual rooms shall also be controllable via a direct control interface, which shall include, but not be limited to, the following:
   a) Power
   b) Input Select
   c) Channel Selection +/-
2. The system shall allow for management of crawl information of the digital signage player. The user shall be able to simply enter text using the Admin Touch Panel, either directly or via web interface.

N. Emergency Alert

1. The software package shall allow for the broadcast of audio emergency alert or drill messages to all audio zones via IP.
2. The software package shall direct any and all classroom and common area flat panel systems to decode IP multicast video streams generated by third party MPEG-2 or h.264 video encoders , Visionary Solutions or approved substitution. To be used for the broadcast of video emergency alert or drill messages.
3. The alerts/drills shall include at least Lockdown, Emergency, Fire and All Clear.
4. The system shall override current use of the projector by the teacher.
5. The system shall allow for custom messages for each alert/drill screen to be entered at the Admin Touch Panel or web interface.
6. Emergency alerts shall trigger visual, audible and textual alerts through the connected hardware.
7. On command, the system shall provide an all-clear message for one (1) minute to end the alert / drill. After the all-clear message has ended, all displays shall return to their previous state (power and input).
8. Any systems that do not return displays to their pre-alert state shall not be accepted.

O. System Management

1. The software package shall provide a system management page which will consist of the following areas:
   a) System power management
   b) Default volume management
   c) MP3 Bell/Tone/Audio/Recorded voice management
   d) User access management
   e) System time management
   f) Push-to-talk (PTT) microphone zone management
   g) Direct phone paging zone management
   h) Paging chime management
   i) Classroom Status Page
   j) E-mail configuration page
   k) This item intentionally left blank
   l) Projector Alarm Management
   m) PC Management
   n) Schedule management
   o) Alert management
2. System Power
   (1) The software package shall allow certain items in the hardware racks to be powered down for the purposes of conserving electricity.
3. Default Volume
   (1) The software package shall allow these individual sources to be adjusted to a specific volume:
      (a) Push-to-talk microphones
      (b) PA microphone
      (c) Bells
      (d) Music
      (e) Phone Interfaces
      (f) Program Audio
      (g) Remote Audio
   b) Manage MP3 Files
      (1) The software package shall allow for display of all MP3 files on the Admin touch panel graphical interface. All MP3 files shall reside on a USB flash drive in the IMS rack and adjusting the duration of each MP3 file.
   c) User Access
      (1) The software package shall allow for management of users and access rights to the system. A practically unlimited number of users can be added to the system with a unique password. Each user can be given access to any or all of the follow areas:
         (a) Audio Events
         (b) Audio Paging
         (c) Video Paging
         (d) Manage Displays
         (e) Background Music
         (f) Remote Audio
         (g) Security Cameras

(h) System Management
(i) Digital Signage
(j) Emergency Alerts
(k) Energy Management
(l) Dial-in Access

d) System Time
(1) The software package shall allow for access to the Internet and network time servers for the purpose of synchronizing time-based system functions and all RS-232 clocks on campus. The system shall provide an internal clock in the event networked time information is not available.
(2) GPS Analog clocks systems will be controlled by the AMX master clock via relay contact closure.

e) Push-To-Talk (PTT) Microphone
(1) See audio paging section.

f) Direct Phone Paging (Basic)
(1) See audio paging section.

g) Alerts
(1) The software package shall provide for system alerts, which shall be audible, visual and textual. These alerts can be triggered by contact closures such as doorbell switches or motions sensors. In addition, alerts can be triggered by virtual switches tied to the interruption of network communication between the system and the classroom devices. Physical or virtual web call/panic buttons shall be available to every classroom system. Audible alerts shall be available to all PA/Intercom zones and have an assignable MP3 audio file.
(2) Visual alerts shall be available on the graphical interface via the touch panel or teacher interface. Text alerts shall be sent to any personnel assigned to receive e-mail alerts specific to the occurrence. The system shall support display of selected security camera streams on the graphical interface based on specific triggered occurrences.

h) Projector Alerts
(1) The software package shall allow for defining of a start and end time which will establish a period of time for which a trigger can be customized.
(2) The customization shall include the assigning of an MP3 tone and a zone for which the MP3 shall be played.
(3) There shall be 3 defined times which are Daytime, Nighttime and Holiday.
(4) Daytime and Nighttime hours shall be opposite of each other
(5) Holiday times shall be determined by enabling the “Switch Alerts to Holiday Mode” setting in the System Power section of the System Management page.
(6) System Response: When a display managed by the Unified Campus System is disconnected from the network or the power cord is removed. The following shall occur:
(a) Different response activities are supported for each of the Daytime/Nighttime/Holiday periods.
(b) An e-mail shall be sent to selected school personnel (or distribution list)

(c) A visual alert shall be displayed on the touch panel pinpointing the exact location of the occurrence

(d) An MP3 tone shall be played through the PA system to a designated zone setup by the user

i) Panic Button/Office Call

(1) See also Voice Reinforcement & Panic Button (optional)

j) Doorbells/ Miscellaneous Alarms

(1) Through the control processor, the Unified Campus System can receive multiple alerts from devices such as doorbells, motion sensor, door contacts, etc. The system shall allow for the defining of a start and end time which will establish a period of time for which a trigger can be customized. This trigger can be activated by a contact closure. The touch panel interface shall allow for assigning an input address to a specific named alert. The customization shall include the assigning of an MP3 tone and a zone for which the MP3 shall be played. There shall be 3 defined times which are Daytime, Nighttime and Holiday. Daytime and Nighttime hours shall be opposite of each other and Holiday times shall be determined by the setting in System Power section and by selecting the “Switching Alerts to Holiday Mode” to the active state.

(2) Scenarios and responses are identical to the projector alerts but are assigned to an individual contact closure on campus. This is to provide entry/exit alarms or chimes to the campus.

k) E-mail Notification

(1) The software package shall allow entry of e-mail addresses of individuals to receive e-mail alerts for, but not limited to, the following:

(a) Panic button alerts

(b) Projector / Display alerts

(c) Door alerts

(2) The Unified Campus System shall allow for the storage of multiple e-mails addresses of key campus or district personnel. Addresses can be assigned to various triggered alerts for the purposes of notifying campus or district personnel. Alerts can be triggered by physical contact closures (push button), switches, or virtual web button presses.

l) Enhanced Telephone Interface

(1) The software package shall allow ability to access the system from any telephone or cell phone. The enhanced telephone interface will allow for control or access to the following:

(a) Manual bells

(b) Zoned paging system

(c) Manage Projectors

(d) Emergency alerts

(e) Telephone interface shall allow for triggering of any of the 6 manual bells that have been configured for zones and have been assigned an MP3 file. The telephone interface shall also allow for paging any of the configured paging zones and allow the phone microphone to act as the paging microphone to address any and all zones on campus. The telephone interface shall allow the user to power all projectors on or off. The telephone interface shall allow the user to trigger any emergency alerts/drills and trigger the all-clear message.

m) Classroom Software (Interface)

(1) Provide a Unified Campus System classroom control interface to allow the teacher to control the local classroom Audio/Video system. Various degrees of control shall be available depending on the type of interface provided.

(a) 8-Button Control Keypad: The application shall have the capability to utilize an 8-button control keypad to provide basic room system control such as, projector power, source selection, streaming video channel selection, room volume control, audio mute and push to talk.

(b) All Unified Campus classrooms, regardless of selected UI, shall have access to a Teacher Client and on-screen Toolbar.

(i) Must support PC users

(ii) Must support Mac users

n) Classroom Software (Functions)

(1) Provide the Unified Campus System password protected classroom software application to allow the classroom teacher to control the following:

(a) Room controls

(b) Local Source selection

(c) Video Source(s) selection and control

(d) Intercom control

(e) Energy management

(f) Tools

o) Classroom Projector

(1) The Unified AV System graphical classroom interface shall provide basic projector controls, display streaming channel selection, room volume control and volume mute.

p) Local Sources

(1) The Unified Campus System graphical classroom interface shall provide the capability to switch the projector and audio to local classroom sources such as a classroom computer, DVD player, document camera, campus video channel, or campus background audio.

q) Video Sources

(1) The Unified Campus System graphical classroom interface shall provide for the capability to select from a list of headend sources such as DVD players, satellite receivers, cable boxes and/or DVRs to be controlled and streamed over the network. All devices shall have basic transport controls and other controls normally found on the IR remote of the device. The system shall allow for a preview window within the web client and once the appropriate media source as been selected, a “Send to Projector” function will send the desired media source directly to the classroom projector with a single button press. In the event a user in another classroom accesses this section of the user controls menu while a device is already being controlled, that source button shall appear as orange and a pop-up message shall offer the option to view without control. This is to avoid control conflicts of shared resources. Room control of shared resources shall be automatically released upon triggering the “Release Control” button or 60 minutes of no interaction. Systems not providing source control conflict notification shall not be accepted. These controls shall be available to the teacher in the classroom via the web client or 4.3-inch touch panel interface.

r) Favorite Channels

(1) When a dedicated video stream is assigned (fixed) to each desired Cable / Satellite channel, the Unified Campus System graphical classroom interface shall have the capability to have predetermined channels represented by the broadcast channel logo or icon. The user shall have the capability to preview the video embedded within the web client. Once the user has selected an appropriate video stream, the system shall have a “Send to Projector” function allowing the teacher to send the current video stream directly to the projector with a single button press.

(2) Favorite Channels are not supported when each cable / satellite tuner allows the viewer to select their desired channel.

s) Intercom

(1) The Unified Campus System graphical classroom interface shall provide for 2-way communications between the classroom and the front desk or Gym or Multipurpose room. Other functions shall include press-to-talk, place call, do not disturb, hang up call, and hands free.

(a) Up to 4 Admin Interfaces

(i) 1-4 Admin Touch Panel(s)

(ii) 1-3 iPad via TPControl license

t) Energy Management

(1) The Unified Campus System shall provide an interface to other systems, allowing administrators to exercise control of computer power management, classroom and common zone lights and HVAC functions as appropriate. Teachers have local override capability for computer power management.

(a) Classroom Computer Power Management

(i) The Unified AV System software shall allow for the management of any PC/Mac computers on the campus LAN. The software via the touch panel interface shall allow for the assigning of computers to specific rooms. Each computer shall be addressable by computer name or Mac address. The system shall provide practically unlimited combinations of rooms to be saved as named zones. Each zone can be set to a specific time to shut down all computers in that zone for the purpose of conserving energy. The system shall provide a user-friendly interface to easily change the shutdown times or temporarily override the shutdown procedure. One application for this override is for the purpose of pushing out updates to the PCs. Immediately prior to the shutdown of any computer being managed, a pop-up message will appear on the user's desktop for 60-seconds, alerting the user to the shutdown and allowing time to save documents and exit programs. The pop-up message will also provide the user the ability to delay the shutdown. When the subsequent shutdown time arrives, the same pop-up message will appear allowing for more time to be selected. If no entry is made, the computer will shut down as scheduled.

(ii) The user shall have the option to override the campus wide shutdown of classroom computers using the Touch Panel or Web client interface as provided. The available override times shall be 15, 30, 60, or 120 minutes. "Shutdown Now" shall also be provided as an option.

(b) Lights

(i) Lighting controls shall be supported

(a) AMX ClearConnect by Lutron

(b) Other systems via FieldServer Gateway

(ii) The following lighting controls shall be supported:

(a) Zone 1 ON

(b) Zone 2 ON

(c) Zones 1&2 ON

(d) All OFF

(c) HVAC

(i) When used in conjunction with the FieldServer QuickServer Gateway, the Unified Campus System software shall provide simple climate controls of the classrooms and other zones from the Admin TP as supported by the mechanical system(s).

(ii) The system shall support Selected Zone(s) On or Off

(iii) The system shall support Setpoint + and –

(iv) Control of all listed functions shall be limited to remain within the facility's energy management policy.

(v) The system shall support multiple OEM protocols:

(a) BACnet

(b) Mod bus

(c) Lonworks

(d) Metasys

(2) Systems that do not provide a floorplan-based Energy Management interface shall not be accepted.

u) Tools

(1) The graphical classroom interface shall provide a stopwatch application and countdown timer. The user shall have the capability to place a stopwatch or countdown timer pop-up on the teacher's computer desktop for the purpose of timing students or events.

(2) The software package described above shall be required to fulfill a complete Unified Campus System specification. All software modules and capabilities described here are included within the software package.

v) Voice Reinforcement

(1) The Unified Campus System supports voice reinforcement .

(2) See also section 27 4100 Classroom Audio Systems.

P. General Equipment And Material Requirements

1. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
2. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
3. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with TIA/EIA-310-D.
4. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

Q. Administration Location

1. Provide a password protected interactive touch panel in the administration area of the school campus. The touch panel shall provide access to and control of the Unified Campus System software. System shall provide one wall mounted microphone and one push-to-talk microphone. There shall be a ceiling mounted speaker with an associated volume control. The software shall allow for network access and control of the administrative touch panel from anywhere on the school's LAN or district WAN.
2. Required hardware :
   a) Admin touch panel: AMX FG5968-13 MXD-1000L (Wall Mount), provide three.
   b) AMX rough-in box Model # FG039-17, provide three.
3. Required hardware for optional features:
   a) Gooseneck wall mount microphone (Shure 503BG with G12, or equivalent)
   b) Push-to-talk microphone (Shure 522 or equivalent)
   c) 8-ohm volume attenuator (DAT8ST or equivalent)
   d) 1' x 2' lay-in tile 8-ohm speaker (Lowell LT-810-BB or equivalent)

R. Audio Rack Location

1. Provide standard rack enclosure for all equipment listed below to reside in the MDF location. Provide all shelves, rack mount kits, rack power supplies, backup power supplies, doors, rack top, lacing bars, etc. as needed to have a neatly dressed rack. The required hardware shall consist of, but not be limited to, the following:
2. Required hardware:
   a) Equipment rack: Middle Atlantic WRK-4432, CPI or approved equivalent
   b) AMX NI-3100 (Qty. 1 – Primary Master)
   c) AMX NI-700 (Qty. 4)
   d) AMX PSN6.5 power supply (Qty. as needed)
   e) AMX AC-RK rack mount kit (Qty. as needed)
   f) Barix Annuncicom 50SV (Qty. 3 – audio encoders with license)
   g) Barix Exstreamer 100 (Qty. 1 – bell player)
   h) Barix Exstreamer 100 (Qty. 1 – voice menu player for Enhanced Phone)
   i) USB flash drive (Qty. 2 – bell & voice menu MP3 file storage)
   j) Barix equipment rack mount (Qty. 1 per every 4 Barix devices in headend rack)

k) Amino H140 or AMX MA1350-85 network video decoder (Qty. 1)

l) Audio summing devices (Qty. as needed): Whirlwind PodDI

m) Applied Technical Systems CC186R rack mount clock (Qty. 1) plus power supply as needed to support clocks throughout campus

n) 70-volt amplifier, Bogen 250 watt or equivalent

o) Network switch (Qty. as needed, Owner Furnished Contractor Installed)

S. Video Rack Location

1. Provide standard rack enclosure for all equipment listed below to reside in the library or video media storage location. Provide all shelves, rack mount kits, rack power supplies, backup power supplies, doors, rack top, lacing bars, etc. as needed to have a neatly dressed rack. This location shall consist of, but not be limited to, the following:

2. Required hardware for all systems:

a) Equipment rack: Middle Atlantic WRK-4432 , CPI or approved equivalent

b) AMX NI-3100 (Qty. 1 – Source Master)

c) Pelco video switcher with loop thru video (Qty. 1)

d) Digital Signage (Qty 6)

(1) Required:

(a) AMX FG1231-01 player

(b) AMX FG1231-20 Standard License

(c) AMX FG525 or FG1231-71 mounting bracket

e) MPEG-2 or h.264 video encoders

(1) 1 per video source (composite, S-Video, YPbPr, HDMI)

(2) Approved: Visionary Solutions AVN-200

f) Video sources – must be IR-controlled using codes from AMX IR Library or submit remote control for capture)

(1) DVD Player (Qty. 1 per classroom)

(2) Satellite Receiver (Qty. 1)

(3) DVR (Qty. 1)

(4) Analog Classroom Camera (Qty. 1 per classroom)

g) 19” rack mounted preview monitor (LCD) with composite video input and integrated speakers

h) Audio summing / Attenuation devices (Qty. 6)

(1) Approved: Whirlwind PodDI

T. Remote Audio Locations:

1. Provide integration of new stand-alone sound systems such as the following:

a) Gym sound systems

b) Cafeteria sound systems

c) Required: Barix Annuncicom 100SV. Admin touch panel: AMX FG5968-13 MXD-1000L (Wall Mount) / AMX rough-in box Model # FG039-17 and all required software. Qty. 1 per stand-alone system.

2. Control volume levels and source selection for the gym and multipurpose sound systems.

a) See drawings for Control Panel locations.

b) Configure the controls to provide audio source and output signals to each individual room or as a larger combined space. Refer to sound system drawings and specifications.

c) Configure the controls to provide video source and output signals to each individual room or as a larger combined space.

U. Common Areas Clocks

1. Provide a digital clock system, which will interface to the Unified Campus System. Clock subsystem shall be RS-232 controllable. Each clock shall be daisy chained to the next, and back to the audio rack location. Provide quantities and styles as needed.
   a) Acceptable: ATS CC2002 single sided wall clock
   b) Acceptable: ATS WG2091 guard for gym (clock not included)
   c) See also 275313.

V. Classroom Hardware Configurations

1. Unified Campus classrooms are fully featured classrooms with integration of local A/V sources, head end based and remote audio sources (bells, PA, background music, push-to-talk microphones, gym & cafeteria audio systems, etc.) and head end based and remote video sources (DVD players, TV tuners, broadcast cart, emergency alerts, etc.)
2. SchoolView Unified Campus options shall include the following hardware:
   a) SchoolView 2’ x 2’ ceiling enclosure
   b) SchoolView Equipment Tray for ceiling enclosure or surface mount
   c) Audio Decoder (Barix Annuncicom 50SV)
   d) Microphone for Intercom
   e) Push-to-Talk or Call Button
   f) Video Decoder (Amino H140)
   g) AMX AVX-400 CAT5 presentation AV switcher with audio amplifier
   h) AMX UPX-CN+A-US
   i) System cabling (minimum of one of each shown below or as shown on Drawings)
      (1) 2' CAT5 network patch cable
      (2) 2' RCA to captive screw audio cable
      (3) 2' DB9 Female to captive screw RS-232 cable
      (4) VGA cables
      (5) HDMI cable
      (6) RS-232 cable with appropriate connectors based on display
      (7) 2 conductor speaker cable (length as needed)
   j) Teacher Client plus interfaces:
      (1) AMX SP-08 8 button keypad (1 per classroom)
3. The Unified Campus classroom includes the teacher interface and toolbar PC/Mac based interfaces. Classroom control features vary with interface, but shall include these as MINIMUM REQUIREMENT:
   a) Display Power Control
   b) Input Select
   c) Volume Up / Down
   d) Mute
   e) Push-to-Talk (for Intercom)
   f) Channel Up / Down
4. Classroom Display
   a) Flat panel or projector

b) Must support RS232 control, using a published protocol

c) Network control shall be delivered via Audio Decoder's Ethernet bridge function

W. Classroom Input Options:

1. Campus Video
2. Additional UPX-xx input plates
   a) VGA: UPX-RGB+A-DE-W (1 per room)
   b) HDMI: UPX-HDMI+A-DE-W (1 per room)

X. Classroom Installation

1. With SchoolView Ceiling Enclosure
   a) All AV package hardware shall be installed in each classroom using a 2' x 2' lay-in tile equipment enclosure. All equipment within the enclosure, when installed shall be accessible from below the ceiling. A locking removable vented door shall secure all equipment. A slotted tray shall be available to mount all equipment within the enclosure.
   b) Single gang and double gang knockouts shall be available to allow for standard high and low voltage back boxes to be mounted within the enclosure.
   c) The enclosure alone without the slotted tray shall be available to be installed on location during ceiling grid installation. This shall allow for electrical, AV and network contractors to install cable and electrical runs to the enclosure.
   d) The slotted tray shall be available to mount all Unified Campus System hardware offsite while the facility is still unsecured. All interconnect cables shall be connected and tested offsite. IP addresses shall be assigned and projector drivers shall be loaded offsite. Once the facility is secure and classroom construction is complete, the classroom equipment mounted to the slotted tray shall be installed to the equipment enclosure on-site.

Y. NetLinx Masters

1. NI3100 with Primary Master software
   a) 1 per system
   b) This item shall provide Primary controls and communications for the Unified Campus system.
2. NI3100 with Source Master software
   a) 1 per system
   b) Located in Video Rack
   c) This item shall provide IR controls of Campus Video sources (8 max)
   d) Additional control devices may be added for 9+ controlled devices
3. NI700 with Room Master software
   a) Classrooms / Zones shall be assigned to a zone master for distributed processing and management. Physical location and network topology to be determined during project design phase in conjunction with the site's network design team. Provide 4.
4. NI700 with Flat Panel Software (FPS)

Z. Battery Backup Power Unit

1. Unit shall be rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.

2. Unit shall supply public address equipment with appropriate power automatically during an outage of normal 120-V ac power.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Equipment shall be furnished and installed in accordance with manufacturer's recommendations in compliance with all local, city, state and national codes.

1. Provide all hardware, framing members, etc. as required for mounting supports.
2. All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.
3. The installation of all work shall be neat and of professional quality. Cooperate with other trades in order to achieve well-coordinated progress and satisfactory final results. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.
   a) It is the Contractors responsibility to coordinate necessary configuration details of the data network equipment (by others), such as:
      (1) Configuration of IGMP snooping on all data switches which will receive IP multicast traffic, to prevent flooding of traffic to ports which do not need it
      (2) Configuration of at least one IGMP querier on the network
      (3) Allocation of reserved, static IP addresses for all system equipment
      (4) Creation of port-based VLAN(s) for all system equipment, without DHCP service
      (5) Assignment of all dedicated ports to the VLAN described above.
4. Conductors And Cables
   a) Jacketed, twisted pair and twisted multipair, untinned solid copper.
   b) Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
   c) Microphone Cables: Neoprene jacketed, not less than 2/64 inch thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
   d) Plenum Cable: Listed and labeled for plenum installation.
5. Raceways
   a) Conduit and Boxes: Comply with Section 27 0528.33 - Raceway and Boxes for Communications Systems
   b) Outlet boxes shall be not less than 2 inches wide, 3 inches high and 2-1/2 inches deep.
6. Wiring Methods
   a) Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   b) Install plenum cable in environmental air spaces, including plenum ceilings.
   c) Comply with requirements for raceways and boxes

d) Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

e) Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

7. Installation Of Raceways

a) Comply with requirements in Section Raceway and Boxes for Electrical Systems for installation of conduits and wireways.

b) Install manufactured conduit sweeps and long-radius elbows whenever possible.

8. Installation of Cables

a) Comply with NECA 1.

b) General Cable Installation Requirements:

(1) Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.

(2) Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.

(3) Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

(4) Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

(5) Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

(6) Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used.

(7) Open-Cable Installation:

(a) Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

(b) Suspend speaker cable not in a wire way or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.

(c) Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

9. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.02 PROGRAMMING AND CONFIGURATION

A. It is the Contractors responsibility to configure the system in this section according to the Owner's wishes. This includes the set up and assignment of channels, coordination of

services, etc. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the configuration. This agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final configuration.

B. It is the Contractors responsibility to coordinate all IP multicast addresses and port numbers to be used with the Owner and/or Engineer to ensure that they are acceptable, available and unrestricted on the Owners network. This information must be provided in order to create configuration files for the project.

3.03 TESTS

A. Upon completion of installation and satisfactory testing of system by Contractor, the Contractor shall test the system in the presence of the Owner and the Engineer to demonstrate satisfactory performance.

B. System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer's representative or equipment vendor; Submit report indicating result to the Engineer.

3.04 IDENTIFICATION / LABELLING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both end and at each point where the cable is administered.

B. The contractor shall be responsible for applying a permanent label to each cable to indicate source and destination.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.05 TRAINING

A. Provide step-by-step user instructions identifying operator controls for normal use operations. This shall be included with the O&M manuals.

B. The contractor shall arrange for a total of sixteen (16) hours for end user training on the various A/V Systems. This training shall be planned and scheduled with the Owner. Training plan shall be pre-approved by the Engineer/Architect and shall include a review of the proposed syllabus.

3.06 OPERATION AND MAINTENANCE MANUALS

A. Copies of all approved shop drawings with the Engineer's stamp.

B. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of Owner's manuals must contain the proper software viewers for each document type.

C. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types

E. Rack elevations for all systems with rack mounted equipment.

F. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.

G. Provide statement of warranty with O&M Manuals.

3.07 WARRANTY

A. This Contractor shall warrant all workmanship, equipment and material provided under this contract for a period of one (1) year from the date of approval of certificate of contract completion by the Owner. Provide statement of warranty with O&M Manuals.

B. During the warranty period, report to the site and repair or replace any defective materials or workmanship without cost to the Owner. Warranty service shall be rendered within 24 hours after request by the Owner. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

C. Where warranties on individual pieces of equipment exceed twelve months, the guarantee period shall be extended to the warranty period of the particular items.

D. After completion of the work, the Contractor shall submit a Certificate of Warranty, stating commence and expiration dates and conditions of the warranty, for signature of both participating parties. Incremental warranties for complete portions of the work may be negotiated at the discretion of the Owner, if delays occur beyond the control of the Contractor.

END OF SECTION

SECTION 27 5313
CLOCK SYSTEMS

PART - 1 - GENERAL

1.01 GENERAL

A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.

1.02 WORK INCLUDED

A. Master Clock / Transmission System

1. Primary Encoder with GPS Receiver
2. Primary Internal Transmitter
3. Primary External Transmitter B. Wireless Synchronized Devices

1. Analog Clock
2. Digital Clock
3. Alphanumeric Data Display

1.03 RELATED SECTIONS

A. Section 27 0500 - Communications

B. Section 27 5113 – Paging System

1.04 QUALITY ASSURANCE

A. See Section 27 0513

B. All clocks and associated equipment shall be installed in a neat and workmanlike manner.

C. All secondary clocks will be tested and certified for synchronization and Daylight Savings Time adjustment.

1.05 DEFINITIONS

A. GPS: Global Positioning System, a worldwide system that employs 24 satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time, the most accurate and reliable time.

1.06 SYSTEM DESCRIPTION

A. GPS synchronized wireless time system shall continually synchronize clocks, data display units and PA speakers time throughout the facility and wireless PA voice messaging where needed.

B. The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time to all its components. The system shall not require any hard wiring (beside AC power) for all its components. Analog clocks shall be battery operated. Clocks shall automatically adjust for Daylight Savings Time.

C. The system shall provide a text messaging to a specific or group of Alphanumeric Data Display units.

D. Analog Clocks shall be synchronized within 2 milliseconds up to 6 times per day, and each clock shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that overall clock accuracy shall not exceed plus or minus 0.05 seconds.

E. The system shall include an internal real time clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating the right time.

F. The system shall provide an 802.3 Ethernet based network interface to enable system remote programming and maintenance.

G. The system shall incorporate a “fail-proof” design so that a temporary power interruption shall not cause failure of the all system. Upon restoration of power, the system shall resume normal operation without the need to reset the system or any of its components.

H. The system shall include a test pager, to notify maintenance personnel of any system malfunction.

1.07 REGULATORY REQUIREMENTS

A. Equipment and components furnished shall be of manufacturer’s latest model.

B. Encoder, Transmitter and receiver shall comply with Part 90 of FCC rules, as follows:

1. This device may not cause harmful interference, and
2. This device must accept interference received, including interference that may cause undesired operation.
3. Transmitter frequency shall be governed by FCC Part 90.35.
4. Transmitter output power shall be governed by FCC Parts 90 and 74.

C. System shall be installed in compliance with local and state authorities having jurisdiction.

1.08 SUBMITTALS

A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.

B. Operating License: If license is required, submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.

C. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed at the location directed.

D. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.

1.09 SUBSTITUTIONS

A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.

B. Proposed substitutions shall be identified not less than 10 days prior to bid date.

C. Other systems requiring wiring and/or conduit between master and clocks will not be acceptable.

1.10 QUALITY ASSURANCE A.

Qualifications:

1. Manufacturer: Company specializing in manufacturing commercial wireless systems with a documented experience of minimum of 10 continuous years.
2. Installer: Company with documented experience in installation of commercial wireless systems.

1.11 DELIVERY STORAGE AND HANDLING

A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.

B. Store equipment in finished building, unopened containers until ready for installation.

1.12 PROJECT SITE CONDITIONS

A. Clocks shall not be installed until painting and other finish work in each room is complete.

B. Coordinate installation of GPS receiver and external antenna (if used) for access to the roof or exterior side-wall so that the bracket and related fasteners are watertight.

PART - 2 PRODUCTS

2.01 MANUFACTURER

A. GPS synchronized wireless time, voice and data system and its components shall be manufactured by Sapling, Inc, 1633 Republic Road Huntingdon Valley, PA 19006, (215).322.6063 , or approved alternate. Where Sapling parts are called out, appropriate AMX products are acceptable and considered equal.

B. AMX SchoolView, Unified Campus shall be accepted as equal substitution for both master clock and paging system (Section 27 5113) as a complete package.

2.02 CLOCK CONTROLLER

A. The Master Clock / Transmitter shall be the Sapling SMA 3000 or approved alternate. The transmitter shall be:

1. Capable of transmitting data to wireless analog clock and wireless digital clock
2. Capable of receiving a signal from an atomic clock web site via the Internet
3. Controlled via the web

B. Additionally, the master clock shall have software that allows it to:

1. Act as a (S)NTP Server
2. Activate a countdown feature on digital clock models

C. The transmitter shall have a programmable auxiliary relay and shall be programmed anywhere from 1—99 seconds. Upon utilization of the relay, the transmitter will be capable of interfacing with a once a day closure or interfacing with intercom systems.

D. The transmitter shall be capable of acting as a repeater while receiving a signal wired or wirelessly from the main transmitter.

E. Web Interface – The master clock shall be able to be programmed completely from a web interface that can be accessed through any typical web browser such as Microsoft Internet Explorer or Mozilla Firefox. The interface shall allow the user to program all bell schedules, events, display features, IP settings of the master clock and any system setting that the master clock has.

F. The transmitter shall be capable of transmitting data to the SAL wireless analog clock and the SBL wireless digital clock. The master clock shall be capable of receiving a signal from any SNTP time server via the Internet. The transmitter shall utilize 915–928 MHz frequency–hopping technology. The master clock shall be capable of acting as a repeater while receiving a signal wired or wirelessly from the main master clock. The transmitter shall be FCC compliant, part 15 Section 15,247.

2.03 WIRELESS REPEATER

A. Wireless repeater shall be Sapling SMA 1000.

2.04 ANALOG CLOCK

A. The secondary clock shall be a Sapling SAL Series wireless clock or approved alternate. The clock will be capable of receiving a signal from multiple clocks. The clock shall receive and transmit with 915–928 MHz frequency–hopping technology.

B. The clock is to be capable of transmitting the time simultaneously without interfering with each other. The clocks shall include automatic calibration and a diagnostic function that allows the user to view the quality of the signal, the last time the clock received a correction signal, a gearbox test and a comprehensive analysis of the entire clock.

C. The clock shall have a maximum correction time of five (5) minutes. It shall be designed to be used with the Sapling Transceiver or the Sapling Repeater, which can be regulated via Sapling wireless communication protocol. Upon receipt of the wireless signal, the clock will immediately self–correct.

D. The clock shall have a semi–flush smooth surface ABS case. The dial is to be made of durable polystyrene material. The crystal is to be shatterproof, side molded polycarbonate. Glass and visible molding marks are unacceptable.

E. The classroom and administrative area clocks shall be 12 inches in diameter (minimum), have black hour and minute hands.

F. The Gymnasium clocks shall be 16 inches in diameter (minimum), have black hour and minute hands. Gymnasium clocks shall be protected by a cage specifically designed for such purpose that does not interfere with the readability of the clock.

2.05 DIGITAL CLOCK

A. The digital clocks shall be capable of working in one (1) of the following options:

1. 110 volts AC; the clock receives and transmits time every one (1) minute.
2. 24 volts AC/DC; the clock receives and transmits time every one (1) minute.

B. The elapsed timer shall be capable of working in conjunction with either the four (4) digit or six (6) digit digital clocks and shall have the ability to count down or count up.

PART - 3 EXECUTION

3.01 INSTALLATION

A. Provide Clocks in all rooms as adjacent to paging speakers. Final placement may be field determined. Coordinate with Architect elevations.

B. Clock headend equipment shall be installed in Main Equipment Room.

C. Wireless repeater shall be located in the Telecommunications Room (TR).

3.02 START-UP

A. Synchronize secondary clocks with master clock and Intercom System.

B. Cycle through Daylight Savings Time and verify correct time change on all clocks. Document results and include in as-built documentation.

3.03 TRAINING

A. Provide system training to Owner which addresses all phases of operation including:

1. System programming from local PC using a networked connection from the Main Office
2. Remote access methodology
3. Build standard daily schedule for purposes of test and verification of operation.

B. Provide two follow-up sessions of one hour each as requested by the Owner. These sessions shall be within 60 days of system acceptance.

END OF SECTION

SECTION 28 1000

ACCESS CONTROL AND INTRUSION DETECTION SYSTEM

PART 1 GENERAL

1.01 WORK INCLUDED

A. Provide a complete security access control system with alarm monitoring, relay control and owner provided badging. System shall include installation, equipment, wiring, materials, accessories, software, programming, documentation, testing, training and miscellaneous items required for a complete and operational system.

1.02 SUBMITTALS:

A. Submit complete and descriptive shop drawings indicating compliances with the specifications herein. Submit in accordance with Section 01330.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. DMP/Lenel to match District Standard.

B. DMP XR550DNL-G Control Panel.

C. DMP 893A Dual Phone Module.

D. DMP Model 322 Transformer.

E. DMP Model 860 Relay Module.

F. DMP 714 model zone expanders.

G. DMP 716 output expanders.

2.02 EQUIPMENT

A. Refer to Additional Equipment Lists on Drawings and to District Security and Access Control System Standards, attached.

B. Lenel-Security Reader Interface – LNL-1300 for single door application, Lenel-1320 for dual door application. Provide 1 per card access door indicated.

C. Card Reader – HID Thinline II, HID MiniProx (mullion mounted), HID 5395AGN00 with glass mount kit.

D. Pin Pad – HID 5355AGK09 for Arm/Disarm. HID 5355ABK09 for door control.

E. Access Panels – Lenel Enterprise Series.

F. HID proximity Series – Proxpro II. 1326 standard proximity cards. 1386 ISO series cards. Provide 500 cards with system.

G. Wiring – Wire will be provided by Owner for Contractor installation. Provide Owner with required lengths of wire for ordering.

PART 3 EXECUTION

3.01 INSTALLATION

A. The installation shall be accomplished with quality materials in a neat and professional manner. Materials under this section or other sections of the specifications damaged during this installation shall be replaced with new materials at no additional cost to the Owner.

B. Prior to beginning work, hold a coordination meeting to coordinate all interfaces between equipment, rough-in requirements, phasing issues, etc.

C. Verify location of access controller board and CPU with Owner.

D. Sensors and other devices shall be mounted where indicated.

E. Remote reader electronics and junction boxes shall not be installed in inaccessible ceilings. They shall be located in the nearest accessible ceiling and all wiring piped to the security devices.

F. All wiring shall be concealed in raceway, regardless of location.

3.02 PROGRAMMING

A. Provide complete programming of all system components per Owners Instructions.

3.03 TRAINING

A. Provide 8 hours of on-site training utilizing the actual access control system. Training shall include at minimum the following: System programming, operating doors, photo badging and monitoring. At end of training, provide a certification letter indicating the training was given and understood by the attendees.

END OF SECTION

SECTION 28 3110
FIRE ALARM / VOICE EVACUATION SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Furnish and install a complete and satisfactory operating automatic fire alarm / voice evacuation and detection system.

B. System to include control panel, detection devices, notification appliances, manual stations, digital alarm communicating transmitter, remote annunciator, accessories, raceways, wiring, batteries, and any other necessary accessories and installation materials.

C. Provide plans, specifications, equipment list and calculations for permit review by the Fire Marshall.

1.02 DESCRIPTION OF SYSTEM

A. Supervised non-coded annunciated multiplex style, addressable, solid state system with intelligent analog alarm initiation.

B. System Operation:
1. Alarm Caused By: Activation of any automatic detection or manual device, or water flow within sprinkler system.
2. Alarm Initiation to Cause:
   a. Audible and visual zone identification at Control Panel and annunciators.
   b. Lamp to light in base of initiating detector; or if detector is concealed from view, light a remote lamp at nearest visible location.
   c. Closing of selected supply air dampers and HVAC units.
   d. Transmission of alarm to remote monitoring station via 2 line automatic telephone dialer.
   e. All smoke and fire doors to close.
   f. All speakers to play voice-evacuation message.
   g. All strobes to flash.
3. Audible alarm may be manually silenced at Control Panel. Alarm signal circuit and zone alarm light shall remain initiated until actuated devices have been restored to normal and Control Panel reset.
4. Trouble Signal Caused By:
   a. An open or short in detector or signaling loop wiring.
   b. Removing any initiating or signaling device from system.
   c. Moving any sprinkler system valve from the full open position.
   d. Failure of battery charger.
5. Trouble initiation to cause: audible and visual indication at the Control Panel.
6. Audible trouble indication may be silenced at Control Panel. Trouble circuit and zone light to remain initiated until trouble corrected.
7. Trouble circuit to be self-restoring after correction of problem, or have automatic "ring-back" if left in silenced condition.
8. Alarm shall override trouble.

1.03 PLAN SUBMITTAL AND INSPECTION REQUIREMENTS

A. Plans and Specifications submittal: Three complete plans and specifications for fire alarm systems shall be submitted for review and approval prior to system installation. Plan review fees must be paid before picking up the approved set of plans. Plans and specifications shall be submitted to the Permit and Information Center. Provide owner with a copy of the approved plans.

B. Plans and specifications shall include, at minimum, the following information. Provide additional information as required by Fire Marshall:
1. Floor plan with rooms labeled and occupancy use noted.

a. Location of all initiating, notifications devices, control panel, and remote annunciator.
b. Mounting heights and ceiling description where detectors are installed.

2. Point to point system wiring diagram
   a. Devices, controls, and end-of-line location for each circuit.
   b. Number of conductors and wire gauge for each circuit run
   c. Zone identification
3. Voltage drop calculation
   a. Devices, length, resistance of wire, and end-of-line voltage for each circuit
4. Battery calculation.
5. Other information required by the local authority having jurisdiction.

C. Location and Security: The alarm control unit, remote annunciator panel, and access keys to locked fire alarm equipment shall be installed and maintained in a lock box location approved by the Fire Marshall. Lockbox to be provided by the Contractor. Written operating instructions shall be provided within the alarm control unit. Lock box to meet requirements of fire marshal.

1.04 CONTRACTOR DESIGN

A. The equipment shown on the Contract Drawings is to indicate the minimum system required, but may not show all of the Code required components. It is the responsibility of the Contractor to provide a complete fire alarm and communications system as needed to meet all applicable Codes and requirements under this section

B. Raceway, routing, and wiring for the devices are not shown.

1.05 REFERENCE STANDARDS

A. NFPA 72: National Fire Alarm Code

B. NFPA 101: Life-Safety Code.

C. Uniform Fire Code

D. Oregon Structural Specialty Code

E. UL-STD 864, UL-UOJZ.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. FireLite MS9600UDLS (636 POINT), ECC-50/100, ECC-LOC, to match District standard.

2.02 VOICE EVACUATION MASTER PANEL

A. Features:
1. Solid-state. "Mother/Daughter" board configuration.
2. Plug-in modules.
3. Separately fused inputs.
4. Multiple two wire addressable communication loops for zones and devices required.
5. Supervision and sensitivity testing of all circuits and devices.
6. All necessary 24 VDC power supplies.
7. Alarm reset switch.
8. Ground fault indicator.
9. Lamp test switch or lamp supervision.
10. Trouble silencing switch: self-restoring, or with ring-back.

11. Separate system trouble indicator: Supervises circuits and control panel wiring.
12. Audible and visual trouble indication including location and address of device. Visual indication shall be English language readout.
13. Power-on indicator.
14. Separate supervised alarm and trouble indicators for each circuit.
15. Detector circuit to accommodate intermixing of all types of detection and contact devices without resistors or circuits compensating devices at each initiating device.
16. Terminals for remote annunciators and controls.
17. Addressable auxiliary contacts: Two each NO/NC for alarm and trouble.
18. Fire drill switch and an audible alarm silence switch.
19. Detector sensitivity, calibration and identification to be supervised by control panel. Detector sensitivity capable of being changed from the control panel.
20. Amplifiers shall be provided as necessary.

B. Prerecorded Message:
1. Voice system shall be able to record and store a 60 second message.
2. The recorded message shall include evacuation instructions and shall be approved by the Fire Marshall.

2.03 STANDBY POWER

A. Operation:
1. Upon loss of primary power or drop in primary voltage, system shall automatically transfer to battery power without loss of signal.
2. An indicator lamp and pulsing audible annunciator shall indicate when system is on emergency power.

B. Storage Battery:
1. Integral battery to provide 24 hours operation and then sound all alarm signals for at least five (5) minutes, per NFPA 72.
2. 24 volts DC.
3. Battery charger.
4. Battery overcurrent protection.

2.04 MANUAL STATIONS

A. Addressable non-coded semi-flush mount, single-action, fully compatible with ionization and thermal detectors. Key reset, so that once station has been pulled, it cannot be reset by unauthorized personnel. Bright red finish. Engraved "FIRE ALARM."

B. Acceptable Model: Firelite BG12LX.

C. Provide protective shields for all manual pull stations unless otherwise noted. Tamper-proof, clear lexan shield and red frame that easily fits over manual pull stations. When shield is lifted, it sounds a loud, piercing warning horn. Battery-operated horn. Acceptable Example Model: Safety Technology International Stopper II.

2.05 THERMAL DETECTORS

A. Addressable Combination Rate of Rise/Fixed Temperature:
1. Plug-in base, interchangeable with other detectors, 2-wire loop operation.
2. Alarm indicator lamp.
3. Rate of Rise Initiation: 15^{o}F rise over a one-minute period.
4. Fixed temperature initiation: 135^{o}F or 200^{o}F, as shown.
5. Integral communications and built-in device type identification.

B. Acceptable Model: Firelite H355R.

2.06 SMOKE DETECTORS

A. Features:
1. Optical sensing, photoelectric type addressable smoke detector.
2. No moving parts.
3. Alarm indicator LED to pulse only for trouble and alarm signals.
4. Capable of having sensitivity tested and adjusted.
5. Nominal 24V DC 2-wire loop operation.
6. Provision for connecting a remote alarm lamp.
7. Terminal base connection.
8. Concealed socket head screw to prevent tampering.
9. Integral communications and built-in device type identification.
10. The detector shall be capable of bi-directional communication with the control panel.
11. The detector shall be dynamically supervised and uniquely identifiable by the control panel. The control panel shall be capable of analyzing the signal of the detector's analog value for calibration, identification and sensitivity. These values can be displayed by the control panel and monitored for processing according to control panel instructions. The detector's sensitivity shall be individually adjustable from the control panel. Should the detector sensitivity voltage shift beyond an acceptable level and stay there for a predetermined length of time, a discrete detector trouble signal shall be annunciated at the control panel.

B. Duct detectors shall be similar with duct mounting enclosure, sampling tubes, remote test and reset station. Provide relay base with each duct detector. Connect to shut down associated HVAC unit upon alarm.

C. Acceptable model: Firelite SD355 smoke detector, D355PL with CRF300 relay module duct detector.

2.07 SPEAKER/STROBE

A. Speaker:
1. Field selectable taps for 1/8, 1/4, 1/2, 1, 2 Watt operation.
2. 3 selectable dBA levels: 90, 95, 99 dBA Anechoic at 10’ for both tones.

B. Strobe:
1. Capable of being synchronized by adding synchronization module.
2. 0.2 sec maximum pulse duration with 40% duty cycle.
3. Flash rate of 1 Hz to 2 Hz.
4. Clear or nominal white light source not to exceed 1000 cd.
5. Minimum intensity: 75 candela. 15/75 candela unit is not acceptable.

C. Audio and strobe inputs shall be supervised.

D. Acceptable Model: Wheelock Exceder LED High Fidelity series in red.

2.08 SPEAKER

A. Field selectable taps for 0.125, 0.25, 0.5, 1, 2 Watt operation.

B. Input shall be supervised.

C. Acceptable Model: Wheelock Exceder LED High Fidelity series in red.

2.09 LOUDSPEAKER

A. Field adjustable for 0.5 to 15 Watt operation.

B. Input shall be supervised.

C. Vandal resistant, weatherproof

D. Acceptable Model: Wheelock HSR and Wheellock AH-24WP-R exterior series.

2.10 ELECTRONIC STROBE

A. Capable of being synchronized by adding synchronization module.

B. 0.2 sec maximum pulse duration with 40% duty cycle.

C. Flash rate of 1 Hz to 2 Hz.

D. Clear or nominal white light source not to exceed 1000 cd.

E. Input shall be supervised.

F. Minimum intensity: 75 candela. 15/75 candela unit is not acceptable.

G. Acceptable Model: Wheellock STR.

2.11 REMOTE ANNUNCIATOR

A. Furnish and install where shown on the drawings, serial LCD annunciators incorporating the following features:
   1. Two line by 40 character LCD display, displaying clear English language information.
   2. Control switches for system acknowledgements, alarm silence and system reset.
   3. Supervised from fire alarm master control panel.
   4. Annunciator shall be framed in an architectural gray, extruded aluminum frame.
   5. Annunciators shall be mounted as indicated on the drawings.

B. Acceptable Example Model: Firelite ANN80.

2.12 WIRING

A. Type:
   1. UL listed limited energy cable for fire protective signaling, FPLP.
   2. Conductors: Minimum size No. 18 AWG, solid, color coded, shielded where required by manufacturer.
   3. Overall PVC jacket, red color.
   4. Belden Fire Alarm Tray Cable or equivalent.

B. Size: The sizes and quantity of the different wires shall be those specified by the manufacturer. Color code shall be used where specified.

PART 3 - EXECUTION

3.01 WIRING

A. Raceway:
   1. Raceway not required where wiring is accessible and concealed above ceiling or in chase. Raceway is required in all other areas.

2. Install surface non-metallic raceway for surface wiring in finished areas. Install conduit in all other areas where raceway is required.

B. Wire:
1. All wires shall be tagged at all junction points and shall be free from ground or crosses between conductors.
2. One-inch conduit between the FACP and the central station transmitter connection as indicated. Install number of conductors and electrical supervision for connecting wiring as required to suit central-station monitoring function. Provide telephone conductors, jacks, and boxes for connection between transmitter and MPOP.

3.02 INSTALLATION

A. Manufacturer to provide supervision of installation and make final connection of tagged wiring.

B. Maintain existing system fully operational until new has been tested and accepted. As new equipment is installed label existing equipment "NOT IN SERVICE UNTIL ACCEPTED".

C. Ground equipment and conductor and cable shields. For audio circuits, minimize to the greatest extent possible ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

D. The Contractor shall provide for a communication line from the fire alarm master to the Sonitrol security panel for monitoring alarm conditions. The Contractor shall pay all costs associated with connecting to the Sonitrol panel.

3.03 FIELD QUALITY CONTROL

A. Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Pretest: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Pretest shall include the following:
1. Determine the conformance of the system to the requirements of the Drawings and Specifications.
2. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
3. Perform sound level test. Adjust volume of all speakers to minimum level required to maintain sound levels of 15 dB above ambient sound levels throughout building. Retest sound level with owner present and note sound level setting of all horns on drawings. Notify owner if additional speakers are required.
4. Prepare forms for systematic recording of acceptance test results.
5. After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.

C. Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

D. Final Acceptance Test: Test the system according to the procedures outlined in NFPA 72. Minimum required tests are as follows:
1. Verify the absence of unwanted voltages between circuit conductors and ground.
2. Megger test all conductors other than those intentionally and permanently grounded with electronic components disconnected. Test for resistance to ground. Report readings less than 1-megaohm for evaluation.
3. Test all conductors for short circuits utilizing an insulation-testing device.
4. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.

5. Verify the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
6. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
7. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
8. Test the system for all specified functions according to the manufacturer's operating and maintenance manual. Systematically initiate specified functional performance items at each station including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
9. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the period and in the manner specified.

E. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

F. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.

G. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

3.04 CLEANING AND ADJUSTING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.05 DEMONSTRATION

A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours training.
2. Schedule training with the Owner at least seven days in advance.

3.06 CERTIFICATION

A. The installer shall provide written certification to the fire marshal and to the Owner that the system has been installed in accordance with the approved plans and specifications.

END OF SECTION

SECTION 31 20 00
EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preparing subgrades
   2. Excavating and backfilling for buildings and structures.
   3. Select Fill for concrete slabs-on-grade and footings.
   4. Base course for concrete walks and pavements.
   5. Base course for asphalt paving.
   6. Excavating and backfilling for utility trenches.
   7. Drainage fill and Growing Media for infiltration facilities.

1.2 SUBMITTALS

A. Product Data.

B. Aggregate Sieve Analysis.

C. Sample of intended fill materials provided to the Architect and Geotechnical Engineer for approval prior to delivery to the site.

D. Growing media: (at least 14 days in advance of construction).
   1. Documentation for the two analyses described in article 2.1.N.1 and 2.1.N.2 of this specification (particle gradation with calculated coefficient of uniformity; and pH) shall be performed by an accredited laboratory with certification maintained current. The date of the analyses shall be no more than 90 calendar days prior to the date of the submittal. The report shall include the following information:
      a. Name and address of the laboratory.
      b. Phone contact and e-mail address for the laboratory.
      c. Test data, including the date and name of the test procedure.
   2. A compost technical data sheet from the compost vendor. The analysis and report must conform to the sampling and reporting requirements of the US composting Council Seal of Testing Assurance (STA) program. The analysis shall be performed and reported by an approved independent STA program laboratory and be no more than 90 calendar days prior to the date of submittal.
   3. Two gallon-sized bags of the blended material.
   4. A description of the location, equipment, and method proposed to mix the material.

1.3 DEFINITIONS

A. Wet Weather: Any weather or subgrade conditions that preclude compaction of subgrade or created workability problems.
   1. Any time between October 14th and April 15th should be considered wet weather regardless of subgrade conditions.
   2. Any time subgrade is outside of optimum moisture content should be considered wet weather regardless of date.

B. Backfill: Soil material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

C. Base Course: Course placed between the subbase course, or subgrade, and concrete, or hot-mix asphalt paving.

D. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

E. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

F. Select Fill: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for Allowances, Unite Prices, and changes in the Work.
   2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

H. Fill: Soil materials used to raise existing grades.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subgrade: Surface or elevation remaining after completing excavation, or the top surface of a fill or backfill immediately below subbase, drainage fill, Select Fill, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

L. Drainage Fill: Free draining, open-graded aggregate course used to support pervious pavement or in drainage zones in flow-through planters, vegetated stormwater facilities and infiltration galleries.

M. Choking Layer: Free draining, small, open-graded aggregate course used to filter out fines prior to stormwater reaching stormwater facility reservoirs.

N. Growing media: Non-native soil mixture made up of sand, loam, and compost; used on surface stormwater facilities.

O. Unified Soil Classification System:
   1. GW: Well-graded gravels; gravel/sand mixtures with little or no fines.
   2. GP: Poorly-graded gravels; gravel/sand mixtures with little or no fines.
   3. GM: Silty gravels; poorly-graded gravel/sand/silt mixtures.
   4. GC: Clayey gravels; poorly-graded gravel/sand/clay mixtures.
   5. SW: Well-graded sands' gravelly sands with little or no fines.
   6. SP: Poorly-graded sands; gravelly sands with little or no fines.
   7. SM: Silty sands; poorly, graded- sand/gravel/silt mixtures.
   8. SC: Clayey sands; poorly-graded sand/gravel/clay mixtures.
   9. ML: Inorganic silts; sandy, gravelly, or clayey silts.
   10. CL: Lean clays; inorganic, gravelly, sandy, or silty, low to medium-plasticity clays.
   11. OL: Organic, low-plasticity clays and silts.
   12. MH: Inorganic, elastic silts; sandy, gravelly or clayey elastic silts
   13. CH: Fat clays; high-plasticity, inorganic clays.
   14. OH: Organic, medium to high-plasticity clays and silts
   15. PT: Peat, humus, hydric soils with high organic content.

1.4 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

C. Site Information: Research public utility records and verify existing utility locations prior to ordering any material. Notify the Architect immediately if any discrepancies are found in the project survey.

D. See Geotechnical report titled Jefferson/ATA Middle School Geotechnical Investigation and Seismic Hazard Study by Foundation Engineering, Inc. dated May 28, 2015 for additional information and requirements.

E. There are highly plastic and moisture-sensitive soils on site that will require overexcavation. The Geotechnical engineer must be on site during footing excavation to determine depths of excavation.
   1. Areas that do not have high plasticity clay are still very moisture-sensitive and may require replacement with base course per direction from the Geotechnical Engineer.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
   2. On-site soils are considered unsatisfactory and may not be used as fill.

D. Base Course: Use Oregon Standard Specifications for Construction 3/4-inch-0" BASE AGGREGATE.

E. Engineered Fill (Called Granular Site Fill in Geotechnical Report): Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; well-graded, with at least 90 percent passing a 3-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Bedding Course: Use Oregon Standard Specifications for Construction ¾-inch—0-inch BASE AGGREGATE.

G. Select Fill: Well-graded mixture of, clean, washed crushed stone, or crushed gravel; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 200 sieve.

H. Backfill and Fill:
   1. Satisfactory soil materials
   2. Initial trench backfill: Use OREGON STANDARD SPECIFICATIONS FOR CONSTRUCTION 3/4-inch – 0-inch base aggregate.

I. Drainage Fill: Angular, granular material with a maximum particle size of 2 inches and shall meet Oregon Standard Specification 00430.11. The material shall be free of roots, organic material, and other unsuitable materials; have less than 2 percent passing the No. 200 sieve (washed analysis); and have at least two mechanically fractured faces.

J. Choking Layer: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; AASHTO course-aggregate grading size #7.

K. Growing Media: A loose and friable material blend of loamy soil, sand and compost that is 30-40 percent compost (by volume) and meets the following other criteria:
   1. Particle Gradation: A sieve analysis of the complete blended material shall be conducted per ASTM C117/C136, AASHTO T11/T27, or ASTM D422/D140 and meet the following gradation criteria:

Sieve Size	Percent Passing
1-inch	100
#4	75-100
#10	40-100
#40	15-50

#100	5-25
#200	5-15

The blend shall have a coefficient of uniformity (D60/D10) equal to or greater than 6 to ensure it is well graded.

2. Acidity: pH of the blended material shall be tested and be between 6 and 8.
3. Compost: The compost shall be derived from plant material and provided by a member of the US Composting Council Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of local providers. The compost shall be a result of biological degradation and transformation of plant-derived materials under conditions designed to promote aerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have no visible free water and produce no dust when handled. It shall meet the following criteria, as reported by the US Composting Council STA Compost Technical Data Sheet provided by the vendor.
   a. 100 percent of the material must pass through a ½ inch screen.
   b. The pH of the material shall be between 6 and 8.
   c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0 percent by weight.
   d. The organic matter content shall be between 30 and 70 percent (dry weight basis).
   e. Soluble salt content shall be less than 6.0 mmhos/cm.
   f. Maturity indicator shall be greater than 80 percent for Germination and Vigor.
   g. Stability shall be 'Stable' to 'Very Stable'.
   h. Carbon/Nitrogen (C/N) ratio shall be less than 25:1.
   i. Trace metals test result= 'Pass.'
4. Blend: The material shall be well mixed and homogenous. It shall be free of wood pieces, plastics, and other foreign matter. There shall be no visible free water.
5. Infiltration: The blended material shall have a minimum infiltration rate of 2 inches per hour. Contractor shall provide the Engineer with a 2 quart sample for initial testing.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction or as follows:
   1. Red: electric.
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

B. Tracer Wire: 12 AWG minimum solid copper insulated High Molecular Weight Polyethylene (HMW PE) tracer wire or approved equal. The tracer wire insulation shall be green for sewer pipe and blue for waterlines and be a minimum of 45 mil. thick. Joints or splices shall be waterproof. The wire shall be rated for 30 Volt.

C. Impermeable liner: PVC or HDPE Geo-membrane textured on both sides, 30 mil (.076mm) minimum.

D. Drainage Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
   1. Grab Tensile Strength: 200 lbf; ASTM D 4632.
   2. Tear Strength: 40 lbf; ASTM D 4533.
   3. Puncture Strength: 220 lbf; ASTM D 4833.
   4. Apparent Opening Size: No. 40; ASTM D 4751.
   5. Permativity (minimum): .5 sec^{-1}; ASTM D 4491.

E. Separation Fabric: Woven geotextile, specifically manufactured as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties and referenced standard test methods:
   1. Mean Average Roll Value (MARV) strength properties meeting AASHTO M 288-06 Class 2 for woven geotextile.
   2. MARV hydraulic properties meeting AASHTO M 288-2006 with permittivity greater than 0.1 sec -1, and an apparent opening size of less than 0.6 mm..

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations. Provide protective insulating materials as necessary.

B. Protect and maintain erosion and sedimentation controls, which are specified the 1200-C Permit and Plans.

C. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

D. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

E. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

F. Protect all areas designated to be infiltration facilities from foot or equipment traffic and surface water runoff. Do not use proposed infiltration facilities to dispose of surface water runoff during construction. Under no circumstances shall material and equipment be stored on top of the installation area. Contractor shall not backfill facility until Engineer has inspected it and signed off.

G. Dry Weather Preparation:
   1. Demolish existing slabs and foundation elements and dispose outside of new construction area.
   2. Strip the landscape areas as required to remove all topsoil, sod, roots, or organic matter. Dispose of all strippings outside of construction areas. The strippings should be hauled from the site or reused only in landscape areas. No strippings should be placed beneath foundations, slabs, sidewalks, or pavements.
   3. The depth and extent of any plastic clay, and the need for overexcavtion be determined by the Geotechnical Engineer. Pothole the existing building pad to establish the thickness and quality of the existing building pad fill and to determine if high plasticity clay is present beneath the fill. Geotechnical Engineer to review pothole and determine the presence of high plasticity clay and the need for overexcavation.
   4. If the existing building pad is at least 12 inches think and is not underlain by high plasticity clay, use a smooth drum roller to compact the surface of the existing base rock to mitigate disturbance caused by the demolition work or site stripping. Proof-roll the surface of the base rock using a loaded dump truck, or other heavy equipment approved by the Geotechnical Engineer, to identify any soft or pumping areas. Overexcavate any pumping base rock or subgrade and replace it with compacted Select Fill.
   5. Do not allow subgrade to dry. Immediately cover the subgrade with Separation Fabric.

H. Wet Weather Preparation:
   1. If wet weather construction is necessary, provide Separation Fabric, a minimum of 12 inches of compacted Select Fill over 12 inches minimum of compacted Base Course under the building pad and any staging areas. Over excavation may be necessary to achieve the 24 inches of fill required.

3.2 EXPLOSIVES

1. Explosives: Do not use explosives.

3.3 EXCAVATION

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions without prior approval by the Architect.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.4 WET WEATHER GRADING, EXCAVATION, OR FILL

A. No grading shall be done during wet weather without prior approval from Geotechnical Engineer.

B. Building pads, haul roads, and staging areas require the following working pad during wet weather:
   1. Separation fabric
   2. 12 inches of Base Course
   3. 12 inches of Select Fill

3.5 EXCAVATION FOR STRUCTURES

A. Prepare subgrade as described in section 3.1 – Preparation. Overexcavation may be necessary at any time, but will be required during wet weather.

B. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavation a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspection.

C. Excavation within building footprint:
   1. Pothole the existing building pad to establish thickness and quality of existing building pad fill.
   2. If existing building pad is at least 12 inches thick and is not underlain by high plasticity clay, compact surface with a smooth drum roller then proof-roll subgrade under observation of the geotechnical engineer.
      a. Any areas of pumping base rock must be overexcavated and replaced with Select Fill.

D. Excavation outside of existing building footprint:
   1. Excavate to the depth require to accommodate a 12-inch thick building pad where high plasticity clay is not present. The excavation should be completed using a hoe equipped with a smooth-edged bucket to minimize disturbance to the fine-grained subgrade. The subgrade should consist of stiff, low to medium plasticity soil.
   2. Where high plasticity clay is present, excavate to the depth required to accommodate a 3-foot thick building pad. Subgrade conditions to be confirmed by geotechnical engineer during construction.

E. Excavation during wet weather, as defined in section 1.3, will require separation fabric and 12 inches of compacted engineered fill capped with 12” of Select Fill. Subgrade must not be exposed to rain or construction traffic. Install separation fabric and rocked pad immediately after exposing subgrade, under supervision of the geotechnical engineer.

F. Do not allow the subgrade to dry. Immediately cover with separation fabric. The fabric should be laid smooth, without wrinkles or folders in the direction of construction traffic. Overlap adjacent rolls a minimum of 2 feet. Pin fabric overlaps or place the building pad fill in a manner that will not separate the overlap during construction. Seams that have separated will require removal of the building pad fill to establish the required overlap.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

B. Compaction may not be practical if the soils or too wet

C. Excavation during dry weather:
   1. Grade subgrade as required. Do not reuse materials generated by site grading under any sidewalks, parking lots, or foundation areas.
   2. Compact the subgrade under pavements to a depth of 12 inches.

D. Excavation during wet weather and/or on stiff, highly plastic clays:
   1. Do not compact the subgrade during wet weather or if the subgrade if stiff, highly plastic clay. Instead, overexcavate to provide a 24" thick base course section on separation fabric. In lieu of subgrade compaction, the thickened base rock section should be left in place for pavement construction.

E. Cover prepared subgrade with separation fabric and base rock immediately. Do not expose subgrade to weather.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
   1. Clearance: 6 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade and bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
   1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course. Hand excavate for bell of pipes.
   2. Excavate utility structures to provide 6 inches clearance (enlarge as needed) to allow for compaction of backfill material.

3.8 EXCAVATION FOR STORMWATER INFILTRATION FACILITIES

A. Excavate facilities to the indicated gradients, lines, depths, and elevations. All excavations shall be performed with the lightest practical excavation equipment. Excavation equipment shall not be operated within the limits of the facility.

B. To help prevent subgrade soil contamination and clogging by sediment, facility construction shall be delayed until all other construction within its drainage basin is completed and the drainage area stabilized. Provide additional sediment control measures such as diversion berms around the facility as needed. Additional excavation and backfill required to restore any infiltration rate lost due to clogging or over-compaction during construction shall be performed by the contractor at no cost to the owner.

3.9 SUBGRADE INSPECTION

A. Proof-roll subgrade with a full-loaded, pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades. Do not proof-roll subgrade in infiltration facilities.

B. Soft pockets and areas of excess yielding that have been identified shall be scarified and moistened or aerated, or removed and replaced with suitable soil materials to the depth required. Re-compact and retest until specified compaction is obtained.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

D. Geotechnical engineer to observe and approve proof-rolls.

3.10 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean

concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.11 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.12 BACKFILLS AND FILLS

A. Backfill: Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for record documents.
   3. Inspecting and testing underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.13 UTILITY TRENCH BEDDING

A. Place bedding on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

3.14 UTILITY TRENCH BACKFILL

A. Trenches under Footings: Backfill trenches excavated under footings with satisfactory soil or approved backfill to within 18 inches from the bottom of footings elevation; fill remaining trench excavation with concrete up to the elevation of bottom of footings. Concrete is specified in "Cast-in-Place Concrete."

B. Place and compact initial trench backfill material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

C. Place and compact final backfill of satisfactory soil to final subgrade elevation.

D. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

E. Install tracer wire in a continuous fashion above the utility in such a manner as to be able to properly trace utility lines without loss or deterioration of signal or without the transmitted signal migrating off the tracer wire. Bring tracer wire to the surface at every box, vault, drainage structure, or manhole.

F. At all building connections, place a 6-inch thick lens of compacted clay to protect building.

3.15 DRAINAGE FILL

A. Compaction of the native soil subgrade should be limited in order to prevent a reduction in the permeability of the soil.
   1. Where erosion of subgrade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and underlying soils scarified to a minimum depth of 3 inches with a York rake or equivalent and light tractor.

2. Where subgrade has been compacted due to construction traffic, subgrade shall be scarified or removed to a depth sufficient to match the naturally occurring insitu state. Add additional base course material to meet design grades at no cost to the owner.
3. Bring subgrade of base course to line, grade, and elevations indicated. Fill and lightly re-grade any areas damaged by erosion, ponding, or traffic compaction before the placing of stone.

B. Place drainage geotextile over prepared subgrade, overlapping ends and edges at least 12 inches. Secure in place to prevent wrinkling.

C. Place drainage fill and compact by tamping with a plate vibrator, and screed to depth indicated. For drainage fill that exceeds 8 inches in compacted thickness, place fill in layers of equal thickness, with no compacted layer more than 8 inches or less than 4 inches thick.

D. Place drainage geotextile over compacted drainage fill, overlapping ends and edges at least 12 inches.

3.16 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use base course.
3. Under steps and ramps, use base course.
4. Under building slabs, use select fill.
5. Under footings and foundations, use select fill.
6. Under and around utility structures, use engineered fill.

3.17 STORMWATER INFILTRATION FACILITY FILL

A. Growing media shall be placed in loose lifts, not to exceed 8 inches each.

B. Placement of the growing media will not be allowed when the weather is too wet as determined by the owner's representative.

3.18 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 3 percent and is too wet to compact to specified dry unit weight.

3.19 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent. Subgrade compaction should be replaced with overexcavation during wet weather construction.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.

4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

D. Growing media shall be compacted with a water-filled landscape roller. It shall not otherwise be mechanically compacted.

3.20 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Turf or Unpaved Areas: Plus or minus 1 inch.
   2. Walks: Plus or minus 1/2 inch.
   3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.21 BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place base course on subgrades free of mud, frost, snow, or ice.

B. Place separation fabric and base course immediately on prepared subgrade.

C. On prepared subgrade, place base course under pavements and walks as follows:
   1. Shape base course to required crown elevations and cross-slope grades.
   2. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
   3. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

D. Proof-roll prepared base course. Overexcavate and replace any areas of base rock and/or subgrade pumping with additional compacted base course.

E. During wet weather construction or on stiff, highly-plastic clays, place 24 inches of base course on separation fabric over un-compacted subgrade.

3.22 SELECT FILL UNDER CONCRETE SLABS-ON-GRADE AND FOOTINGS

A. Place Select Fill on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact Select Fill under cast-in-place concrete slabs-on-grade and footings as follows:
   1. Place Select Fill that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
   2. Compact each layer of Select Fill to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
   3. Excavate for footings as required. Al loose or disturbed granular fill should be removed or re-compacted in the bottom of the footing trenches or excavations. To expedite foundation construction, a thin leveling course of compacted Select Fill may be placed in the bottom of the footing excavations.

C. Place separation fabric and Select Fill immediately on prepared subgrade. Do not expose subgrade to weather.

D. During dry weather, assume 12 inches minimum of compacted Select Fill.

E. During wet weather, for slab-on-grades, assume 12 inches of compacted Select Fill over 12 inches minimum of Engineered Fill.

F. During wet weather, for footings, assume 24 inches minimum of compacted Select Fill.

G. On highly-plastic clay for slab-on-grades, assume 12 inches of compacted Select Fill over 24 inches minimum of compacted Engineered Fill, or as directed by the Geotechnical Engineer.

H. On highly-plastic clay, for footing, assume 24 inches minimum of compacted Select Fill, or as directed by the Geotechnical Engineer.

3.23 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: Footing and subgrade excavation shall be inspected by Geotechnical Engineer prior to placing backfill.

D. Testing Agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
   1. Paved and building slab areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
   2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 100 feet or less of wall length, but no fewer than two tests.
   3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench length, but no fewer than two tests.

E. With the approval of the Engineer, proof-roll testing of subgrade and/or aggregate base may be substituted for other compaction testing.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.24 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

D. Weather permitting and as approved, stormwater infiltration facility plants shall be installed as soon as possible after placing and grading the growing media in order to minimize erosion and further compaction.

3.25 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt patching.
   2. Hot-mix asphalt paving.
   3. Slurry seal surfacing
   4. Pavement-marking paint.

B. Related Requirements:
   1. Section 31 20 00 "Earth Moving" for subgrade preparation, fill material, aggregate subbase and base courses, and aggregate pavement shoulders.

1.2 SUBMITTALS

A. Product Data: For each type of product. Include technical data and tested physical and performance properties.
   1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the work.
   2. Job-mix Designs: For each job mix proposed for the Work.

B. Material Certificates: For each paving material.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Section 0744 of the 2015 Oregon Standard Specifications for Construction (OSSC) for asphalt paving work.
   1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expect before time required for adequate cure, or if the following conditions are not met:
   1. Tack Coat: Minimum surface temperature of 60 deg F.
   2. Slurry seal: Minimum pavement and air temperature: 45 deg F and rising. See Oregon Standard Specifications for Construction (OSSC) section 706.40 for all weather limitations for slurry seal application.
   3. Asphalt Base and Surface Course:

Dense Graded Mixes	Surface Temperature
Less than 2 inches	60 degrees F
2 inches – 2 1/2 inches	50 degrees F
Greater than 2 1/2 inches	40 degrees F

   4. If placing asphalt between March 15 and September 30, temperature may be lowered 5 degrees F.
   5. Do not use field burners or other devices to heat the pavement to the specified minimum temperature.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil based materials, 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Conform to the requirements of 00744 of the 2015 OSSC for asphalt pavement.

B. Conform to the requirements of 00706.12 of the 2015 OSSC for slurry seal. Reference Type I or Type II slurry seal requirements.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22 or PG 70-22.

B. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt.

C. Slurry seal: OSSC section 706.10.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires, asphalt shingles, or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

C. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.
   1. Color: As Indicated.

D. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
   1. Color: As Indicated.

E. Glass Beads: AASHTO M 247, Type 1.

F. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 6 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
   1. Dowels: Galvanized steel, ¾ inch diameter, 10-inch minimum length.

2.4 MIXES

A. Recycled Content of Hot-Mix Asphalt: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent or more than 30 percent by weight.
   1. Surface Course Limit: Recycled content no more than 30 percent by weight.

B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:
   1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
   2. Provide mixes conforming to section 00744 of the 2015 Oregon Standard Specifications for Construction.
   3. Base Course: Level 2, ½ inch dense, HMAC.
   4. Surface Course: Level 2, ½ inch dense, HMAC.

C. Slurry seal: Type I or Type II slurry seal, meeting the requirements of OSSC 706.15.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Apply tack coat uniformly to vertical asphalt surfaces. Apply at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Asphalt and sand seal edges where new asphalt concrete meets existing pavement.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

E. Slurry seal: prepare the surface per the requirements of OSSC section 00706.

3.4 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Spread mix at a minimum temperature of 250 deg F.
   2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to joints.
   2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
   3. Offset transverse joints, in successive courses, a minimum of 24 inches.
   4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
   1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Cold Milling: Test with a 12 foot (3.7 meter) straightedge furnished and operated by the Contractor, as directed. The variation from the top of the ridges from the testing edge of the straightedge, between any two ridge contact points, shall not exceed 1/4 inch.

B. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 1/2 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

C. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
   1. Base Course: 1/4 inch.
   2. Surface Course: 1/8 inch.
   3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.
   4. Difference between adjacent panels: 1/8 inch.

3.8 SLURRY SEAL

A. Place slurry seal per the requirements of OSSC section 00706.

B. Workmanship:
   1. Slurry seal seams to be straight horizontally.
   2. Slurry seal seams to have less than ¼” edge vertically.

3.9 PAVEMENT MARKING

A. Do not apply pavement-marking paint or thermoplastic material until layout, colors and placement have been verified with architect.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
   1. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal.

3.10 WHEEL STOPS

A. Install wheel stops with dowels.

3.11 CLEANING

A. A minimum of 14 days after placing slurry seal, sweep or vacuum treated area and surrounding area, to collect and dispose of excess or loose aggregates and fines.

B. Do not place pavement markings until after cleaning has been completed.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.13 WASTE HANDLING

A. Except for material indicated to be recycled, remove excavated materials from Project Site and legally dispose of them in an EPA-approved landfill.

END OF SECTION

SECTION 32 13 13
CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Driveways.
   2. Roadways.
   3. Parking lots.
   4. Curbs and gutters.
   5. Sidewalks.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each exposed product and for each color and texture specified.

C. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
   1. Cementitious materials.
   2. Steel reinforcement and reinforcement accessories.
   3. Admixtures
   4. Curing compounds
   5. Applied finish materials.
   6. Bonding agent or epoxy adhesive.
   7. Joint fillers.

E. Minutes of preinstallation conference.

1.3 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301 unless otherwise indicated.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Mockups: Cast mockups of full-size sections of concrete pavement & all finishes to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.
   1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
   2. Notify Architect and Landscape Architect seven days in advance of dates and times when mockups will be constructed.
   3. Obtain Architect's and Landscape Architect's approval of mockups before starting construction.
   4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
   5. Demolish and remove approved mockups from the site when directed by Architect.

6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
   1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete producer.
      d. Concrete pavement subcontractor.

1.4 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
   1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

C. Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

D. Tie bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.
   1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
   1. Portland Cement: ASTM C 150, gray portland cement Type I or Type II
      a. Fly Ash: ASTM C 618, Class C.
      b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S uniformly graded. Provide aggregates from a single source.
   1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   3. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Retardant for Exposed Aggregate: ASTM C494, Type B and D, chloride free, Chem-Masters, L.M. Scofield, or equal. Retardant to be calibrated for aggregate size and finishing requirements.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

G. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.5 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements.

2.6 DETECTABLE WARNINGS

A. Detectable warnings: ADA truncated domes aligned in a square or radial grid pattern complying with current Accessibility guidelines. Detectable warnings shall be concrete precast pavers.
   1. Color: Black or as indicated on Landscape Architect’s plans
   2. Size: Nominal 12 inch x 12 inch.
   3. Thickness: 2 inch.
   4. Manufacturers: Cast in Tact.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
   1. Compressive Strength (28 Days): 3500 psi.
   2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
   3. Slump Limit: 4 inches, plus or minus 1 inch.
   4. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-inch 25-mm nominal maximum aggregate size.

B. Use a qualified testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

C. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.
   1. When temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
   1. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph.
   2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
   3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."

C. Remove loose material from compacted subbase surface immediately before placing concrete.

D. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. After the forms have been set to correct grade, the grade shall be thoroughly tamped, either mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with no less than 3 pins for each 10-foot section. A pin shall be placed at each side of every joint.

C. Form sections shall be tightly locked and shall be free from play or movement in any direction. The forms shall not deviate from true line by more than 1/4 inch at any joint. Forms shall be so set that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment.

D. The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

E. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.4 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
   1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
   1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
   2. Provide tie bars at sides of pavement strips where indicated.
   3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint or install plastic dowel sleeves per manufacturer's recommendations.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
1. Locate isolation joints at intervals of 50 feet, unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
7. Fill joint with type A elastomeric sealant per specification section 07 90 05. Sand per landscape plans.

D. Longitudinal Joints: A longitudinal joint shall be considered a joint parallel with the long dimension of the paving area.
1. Construction: Longitudinal construction joints necessary for lane construction shall be formed against suitable side forms (usually made of steel) with or without keyways, as indicated in the Drawings. Wooden forms may be used under special conditions, when approved by the Engineer. When the concrete is placed using slip-form pavers, the keyway shall be formed in the plastic concrete by means of preformed metal keyway liners which are inserted during the slip-form operations to form the female side of the key and which may be left in place. The dimensions of the keyway forms shall not vary more than plus or minus 1/4 inch from the dimensions indicated and shall not deviate more than plus or minus 1/4 inch from the mid-depth of the pavement. A male keyway may be used providing the keyway and edge tolerances are met. Where butt-type joints with dowels are designated, the dowels for this type shall be painted and greased. The edges of the joint shall be finished with a grooving tool or edging tool, and a space or slot shall be formed along the joint of the dimensions, as indicated, to receive the joint sealing material. Longitudinal construction joints shall be sawed to provide a groove at the top conforming to the details and dimensions indicated on the Drawings. Provisions shall be made for the installation of tie bars as noted on the Drawings.
2. Contraction or Weakened-Plane Type: the longitudinal groove formed in the top of the slab shall be installed where indicated on the Drawings. The groove shall be formed in the plastic concrete with suitable tools or material to obtain the width and depth specified, or it shall be sawed with approved equipment in the hardened concrete to the dimensions required. When the groove is formed in plastic concrete, it shall be true to line with not more than 1/4 inch variation in 10 feet; it shall be uniform in width and depth; and the sides of the groove shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The sawed groove shall be straight and of uniform width and depth. In either case, the groove shall be clean cut so that spalling will be avoided at intersections with transverse joints. Tie bars shall be installed across these joints where indicated on the Drawings.

E. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooved marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

F. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, placing, and consolidating concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.

I. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

J. Screed paving surface with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

L. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

M. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

N. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

O. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

P. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
   3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.6 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
   2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

C. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a ¼ inch (6mm) radius. Repeat tooling of edges after applying surface finished. Eliminate tool marks on concrete surfaces.

3.7 EXPOSED AGGREGATE FINISHING

A. General:
   1. Do not add water to concrete surfaces during finishing operations.
   2. Do not use tools that may force the aggregate away from the surface creating a non-uniform surface after exposure.
   3. Protect all curbs, borders, and adjacent concrete and masonry surfaces, pavers, stones, etc. that are not to receive retarder finish prior to concrete placement and retarder application.

B. Place concrete in the manner described under “Concrete Placement.” Screed or strike off the surface in two (2) directions using a wooden or metal straight edge to achieve the proper elevation in a sawing motion back and forth.

C. Allow the bleed water to evaporate the surface. It can be floated using a wooden hand flaot or a bull-float preferably wooden to close the surface and surround the coarse aggregate with

cement paste. Do not overwork the surface, as this tends to drive the aggregate down and away from the surface to be exposed.

D. Float to a uniform appearance. Exposed aggregate to be between ¼" and ½".

E. Follow all retarder manufacturer's recommendations.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows.

1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:
1. Elevation: ¼ inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed ¼ inch.
4. Joint Spacing: ½ inch.
5. Contraction Joint Depth: Plus 1/4 inch, no minus.
6. Joint Width: Plus 1/8 inch, no minus.
7. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
8. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
9. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
10. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
   1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
   3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
   4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
   5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
   6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
      a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 3113
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fence framework, fabric, and accessories.

B. Manual gates and related hardware.

1.02 RELATED REQUIREMENTS

A. Section 01 3300 - Delegated Design Requirements.

B. Section 03 3000 - Cast-in-Place Concrete: Concrete anchorage for posts.

C. Section 08 7100 - Door Hardware: Hardware for swing gates.

D. Section 33 7900 - Site Grounding.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

C. ASTM F567 - Standard Practice for Installation of Chain-Link Fence; 2011.

D. CLFMI CLF 2445 - Product Manual; Chain Link Fence Manufacturers Institute; 1997.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.

C. Delegated Design Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.

PART 2 PRODUCTS

2.01 MATERIALS AND COMPONENTS

A. Materials and Components: Conform to CLFMI Product Manual.

B. Fabric Size: CLFMI Heavy Industrial service.

C. Intermediate Posts: Type I round.

D. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round.

E. Gates: Swinging and Sliding, manually operated and lockable.

2.02 ACCESSORIES

A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

C. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.

2.03 FINISHES

A. Components (Other than Fabric): Galvanized in accordance with ASTM A123/A123M, at 1.7 oz/sq ft.

B. Components and Fabric: Vinyl coated over coating of 1.8 oz/sq ft galvanizing.

C. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.

D. Accessories: Same finish as framing.

E. Color(s): Black.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install framework, fabric, accessories and gates in accordance with ASTM F567.

B. Place fabric on outside of posts and rails.

C. Set intermediate posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.

D. Line Post Footing Depth Below Finish Grade: ASTM F567.

E. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567.

F. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

G. Provide top rail through line post tops and splice with 6 inch long rail sleeves.

H. Install center brace rail on corner gate leaves.

I. Do not stretch fabric until concrete foundation has cured 28 days.

J. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

K. Position bottom of fabric 2 inches above finished grade.

L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

N. Install bottom tension wire stretched taut between terminal posts.

O. Install support arms sloped inward and attach barbed wire; tension and secure.

P. Do not attach the hinged side of gate to building wall; provide gate posts.

Q. Install gate with fabric and barbed wire overhang to match fence. Install hardware.

R. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

S. Ground fence in accordance with Section 33 7900.

T. Install gate locking device specified in Section 08 7100 - Door Hardware.

3.02 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch.

B. Maximum Offset From True Position: 1 inch.

C. Components shall not infringe adjacent property lines.

END OF SECTION

SECTION 32 3119
DECORATIVE METAL FENCES AND GATES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Delegated Design: Fencing subcontractor to perform design and construction of the fencing and gate system. Design includes footings, excavation and footing depth, detailing, steel connections, fabrication methods, for a complete functioning, secure fencing system as illustrated in the Drawings. Drawings show design intent. Design changes that conform to a similar proprietary fence system and meet the basic specifications below will be permitted.

1.02 SECTION INCLUDES

A. Decorative steel fences and gates.

1.03 RELATED REQUIREMENTS

A. Section 01 3300 - Delegated Design.

B. Section 03 3300 - Cast-in-Place Concrete.

C. Section 08 7100 - Door Hardware: Hardware for swing gate.

1.04 REFERENCE STANDARDS

A. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2015.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.

C. ASTM B117 - Practice for Operating Salt Spray (Fog) Apparatus; 2011.

D. ASTM D523 - Standard Test Method for Specular Gloss; 2014.

E. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint; 2002 (Reapproved 2009).

F. ASTM D822/D822M - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings; 2013.

G. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments; 2008.

H. ASTM D2244 - Test Method for Calculations of Color Differences from Instrumentally Measured Color Coordinates; 2011.

I. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact); 1993 (Reapproved 2010).

J. ASTM D3359 - Standard Test Method for Measuring Adhesion by Tape Test; 2009e2.

K. ASTM F2408 - Ornamental Fences Employing Galvanized Steel Tubular Pickets; 2011.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Delegated Design Drawings:
   1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.

D. Installer's Qualification Statement.
   1. Reference at least three similar projects in the last three years.

E. Manufacturer's Warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

B. Installer Qualifications: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Finish: 10 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Decorative Metal Fences, Basis of Design:
   1. Ametco: www.ametco.com.
      a. Product: Shadow 80; galvanized and powdercoated steel louvered fence system.
      b. 80 percent visual blocking.
   2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FENCES

A. Fences: Complete fully welded, factory-fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:
   1. Capable of resisting vertical load, horizontal load and infill performance requirements for fence categories defined in ASTM F2408.

B. Electro-Deposition Coating: Multi-stage pretreatment/wash with zinc phosphate, followed by epoxy primer and acrylic topcoat.
   1. Total Coating Thickness: 2 mils, minimum.
   2. Color: Silver.
   3. Coating Performance: Comply with general requirements of ASTM F2408.
      a. Adhesion: ASTM D3359 (Method B); Class 3B with 90 percent or more of coating remaining in tested area.
      b. Corrosion Resistance: ASTM B117, D 714 and D 1654; 1/8 inch coating loss or medium No.8 blisters after 1,500 hours.
      c. Impact Resistance: ASTM D2794; 60 inch pounds.
      d. Weathering Resistance: ASTM D523, D822/D822M and D2244; less than 60 percent loss of gloss.

C. Steel: ASTM A653/A653M; tensile strength 45,000 psi, minimum.
   1. Hot-dip galvanized; A653/A653M, G60.
   2. 62 percent recycled steel, minimum.

D. Fasteners: ASTM A276/A276M, Type 302 stainless steel; finished to match fence components.
   1. Tamper-proof security bolts.
   2. Self-drilling hex-head screws.

2.03 GATES

A. Provide gate types as shown in Drawings.
   1. Fabricate of same material finish and infill panel as fence.
   2. Posts that support Gates shall be 6 inch by 6 inch tube steel, galvanized, primed and finished to match Fencing.
   3. Swing Gate: size indicated on drawings. Coordinate to provide backing and mounting for hardware specified in Seciton 08 7100 - Door Hardware. Provide and install additional hardware required for fully functional gate operation.
   4. Sliding Gate: Manual Sliding Cantilevered. Provide all hardware and locking mechanism.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set fence posts in accordance with the manufacturer recommended spacing.

C. When cutting rails immediately seal the exposed surfaces by:
   1. Removing all metal shavings from cut area.
   2. Apply zinc-rich primer to thoroughly cover cut edge and drilled hole; allow to dry.
   3. Apply 2 coats of custom finish spray paint matching fence color.
   4. Failure to seal exposed surfaces in accordance with manufacturer's instructions will negate manufacturer's warranty.

D. Space gate posts according to the manufacturers' drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected.
   1. Base type and quantity of gate hinges o the application; weight, height, and number of gate cycles.
   2. Identify the necessary hardware required for the application on the manufacturer's gate drawings.
   3. Provide gate hardware by the manufacturer of the gate and install per manufacturer's recommendations

3.03 ERECTION TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch.

B. Maximum Offset From Indicated Position: 1 inch.

3.04 CLEANING

A. Leave immediate work area neat at end of each work day.

B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

C. Clean fence with mild household detergent and clean water rinse well. .

D. Remove mortar from exposed posts and other fencing material using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.

E. Touch up scratched surfaces using materials recommended by manufacturer. Match touchup paint color to fence finish.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair, or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 32 8000
IRRIGATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Irrigation System.
B. Backflow Prevention Assembly and related appurtenances.
C. Central Control system, control wires, shrub and lawn zones.

1.02 RELATED REQUIREMENTS
A. Section 01 5639 – Temporary Tree and Plant Protection
B. Section 01 6000 - Product Requirements
C. Section 01 7900 - Demonstration and Training
D. Division 26 - Electrical
E. Division 31 - Earthwork
F. Section 32 9000 - Planting

1.03 REFERENCE STANDARDS
A. ASTM D1784: Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
B. ASTM D1785: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
C. ASTM D2464 - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
D. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
E. ASTM D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2004 (Reapproved 2009).

1.04 PROTECTION
A. Protect existing improvements and growth in areas to remain undisturbed until completion of project. Leave area in similar condition as found.
B. Protect utilities and maintain in continuous operation or in operational condition during work. Repair damage to known utilities at Contractor's expense.
C. Use means necessary to protect materials of this Section before, during, and after installation and to protect installed Work and materials of other trades. In the event of damage immediately make repairs and replacements as directed by Owner's Representative.

1.05 ADMINISTRATIVE REQUIREMENTS
A. Coordination: Coordinate the work with other trades affecting and affected by Work of this Section.
B. Pre-installation Meeting: Convene one week (minimum) prior to commencing work of this Section to coordinate utility marking procedures.

1.06 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Submit manufacturer's printed data covering products and installation instructions.

C. Quality Assurance Data: Submit license information and project references including name and location of previous projects, date of installation, square footage of areas with irrigation work, description of irrigation system, and Owner's contact information.

D. Record Documents: Record actual locations of installed irrigation components on a clean set of plans. Use white out and red ink to legibly re-draft as-built information.
   1. Produce and keep current throughout the project.
   2. Indicate two dimensions for valves, stub outs, and main line T's, L's, ends, elbow's, and change in direction.
   3. Submit to Owner's Representative for approval.

E. Operation and Maintenance Data:
   1. Provide written instructions at System Demonstration for operation and maintenance of system and controls, seasonal activation and shutdown, and manufacturer's parts catalog.
   2. Submit chart showing actual precipitation rates for each zone.
   3. Prepare a program for the irrigation controller for Spring/Summer; Summer; Summer/Fall using historical weather data and averages. Include start times, watering duration, day of week, repeat cycle mode, program mode, precipitation rates in inches per hour, and application quantities. Coordinate operation and programming with Owner's Representative.

F. Maintenance Materials: Provide the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Valve Keys for Manual Valves: One.
   3. Extra Valve Box Keys: One.
   4. Wrenches: One for each type head core and for removing and installing each type head.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing Work of this Section who has successfully completed a minimum of 5 comparable scale projects and have the following licenses:
   1. For Irrigation Work:
      a. Valid Oregon Landscape Contractors license.
      b. Valid Oregon Landscape Business license.
   2. For Plumbing Work:
      a. Valid Oregon Plumbing license.
      b. Valid Oregon Landscape Contractor license.
   3. Successfully completed at least 5 comparable scale projects.
      a. Submit names, addresses, dates, owners and locations of previous projects if requested by Owner’s Representative.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in original unopened packaging with legible manufacturer's identification.

B. Comply with manufacturer's recommendations for storage and protection.
   1. Store in a cool, dry place out of direct sunlight.
   2. Protect from damage by the elements and construction procedures.
   3. Store plastic pipe on firm, level supports.
   4. Store plastic pipe cement in cool location.

1.09 ENVIRONMENTAL CONDITIONS

A. Temperature of mating surfaces of plastic pipe and fittings to be between 40 degrees Fahrenheit and 100 degrees Fahrenheit. Perform no PVC Solvent welding in rainy weather except under cover.

1.10 REVIEWS

A. Request the following reviews by the Owner's Representative two days (min.) in advance:
   1. Irrigation Head Layout Review
   2. Pressure Test and Mainline Installation
   3. System Review
   4. System Demonstration to Owner

B. Coordinate Reviews to coincide with regular progress meetings where possible.

1.11 MAINTENANCE

A. During period between system installation and Final Acceptance provide maintenance to assure proper operation of the irrigation system.

1.12 WARRANTY

A. Warranty period shall be one year following Final Completion or one full operating season following Final Completion, whichever is longer.

B. Contractor guarantees materials furnished under this Contract will be as specified and the Work will be free of defects in compliance with the Contract Documents.

C. Irrigation system must be in proper working condition at the end of the warranty period. At no additional cost to the Owner replace Work of this Section as necessary to restore system to proper working condition following the Contract Documents.

D. Visit and inspect Work at least once a month during warranty period and notify Owner's Representative in writing of any observed conditions requiring attention. Failure to provide such notification renders deficiencies the Contractor's responsibility to rectify.

E. Contractor is not responsible for loss or damage to Work of this Section caused by unusually extreme weather, vandalism, or lack of Owner's maintenance during warranty period.

PART 2 PRODUCTS

2.01 IRRIGATION SYSTEM MATERIALS

A. Use only new materials of brands and types shown on Drawings or specified herein.

B. Similar materials must be products of one manufacturer unless otherwise approved.

C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PIPE MATERIALS

A. Mainline Pipe, Lateral Line Pipe and Irrigation Sleeves: Schedule 40 PVC Pipe, Type 1, normal impact: IPS, NSF approved conforming to ASTM D1784, ASTM D1785.

B. Risers: One piece schedule 80 gray PVC Pipe, Type 1, threaded at both ends conforming to ASTM D1784 and ASTM D2464. No snap-risers.

C. Fittings: Polyvinyl chloride type 1, white Schedule 40 and grey Schedule 80; ASTM D1784, ASTM D2466, or ASTM D2464, as applicable.

D. Swing Joint Assembly Pipe and Fittings: Double swing joint risers as detailed. Swing-Pipe, snap, and "Funny pipe" risers not acceptable.

E. Flex Riser Assembly: 18 inch minimum, 3 feet maximum Swing-Pipe with transfer barb 90 degree ells at both ends and a marlex ell below the irrigation head.

F. Electrical Conduit and Fittings:

1. Underground: Plastic, Class 3, Federal Specification W-C-1094.
2. Above Ground: Aluminum, Federal Specification WW-G-540.

G. PVC Solvent Cement: NSF approved solvent for Class 1245-B&C PVC through 4 inches conforming to ASTM D 2564 for PVC pipe and fittings. Ensure that manufacturer's expiration date is not exceeded.
1. IPS Corporation Weld-on #704 or #711.

H. PVC Cleaner and Primer:
1. IPS Corporation Weld-on P-70 or as recommended by PVC Pipe manufacturer.

2.03 VALVES

A. Isolation Valves - 3 inch and under: Threaded gate valve with resilient wedge sized to match mainline with brass wheel handle.
1. Approved Products:
a. Kennedy model 8057WSS, or approved.

B. Control Valve Assembly:
1. Automatic Control Valve: Globe type, 200 psi rated, threaded connections with cross type operating handle designed to receive operating key. Size according to Valve Schedule on Drawing.
a. Approved Products:
1) Rain Bird PEB-PRS-D Series.
2) Tucor RKLD-050 Line Decoder for 2-wire system.
2. Shut Off Valve: USA manufactured gate valve. 135 psi cold water rated constructed of brass or bronze on 2 inch and under valves with bronze wheel handle.
a. Approved Products:
1) Nibco T-113

C. Quick Coupling Valves:
1. Approved Products:
a. Rain Bird 44 RC.

D. Master Valve: 24V AC, normally open and flanged at both ends.
1. Approved Products:
a. Size: 2 inch.
b. By Superior Manufacture.

E. Flow Sensor: PVC tee type sensor.
1. Approved Products:
a. Model FSI-T20_001 by Creative Sensor Technology.

F. Manual Drain Valve: Globe or angle brass manual valve with non-floating seat disk that allows positive drainage.
1. Approved Products:
a. Manufactured by Champion.

G. Backflow Preventers: Double check valve assembly.
1. Approved Products:
a. Size: 2 inch.
b. Model # 805YD by Febco.

2.04 VALVE BOXES

A. Valve box of suitable size with tee top type lid .
1. Black box and lid in plant bed areas.
2. Black box and green lid in lawn areas.

B. Install valves in the following valve boxes:
   1. Control Valve Assembly: (2) Rain Bird VB-STD, T-Lid.
   2. Quick Coupling Valves: Carson 910-18, T-Lid.
   3. Manual Drain Valves: Carson 910-18.
   4. Isolation Valves: Carson 910-10.
   5. Other Valves: Sized as applicable by Carson.

2.05 IRRIGATION HEADS

A. Makes and models shown on Drawings, or approved.

2.06 WIRE

A. Zone Control Wire: Install according to manufacturer's wire schedule for valve specifications. 14 gauge minimum, type AWG-UF, bearing U.S. approval.

B. Zone Control Wire (2-Wire):
   1. Approved products:
      a. Tucor Control Cable, 16AWG, multiple colors.

C. Communication Wire: Install according to manufacturer's central control requirements. Wire from controller to flow sensor must be a single, un-spliced length.
   1. 19 gauge, PE 39 cable, 6 pair.
   2. Maxicom.

D. Wire Connections: Direct bury splice Kit.
   1. DBR/Y by 3M.

E. Utility Locate Wire: 14 gauge minimum, type AWG-UF, bearing U.S. approval, blue in color.

2.07 IRRIGATION CONTROLLER

A. One (1) Commercial Series, ESP-24SAT-W, Maxicom Central Irrigation Controller by Rain Bird.

B. One (1) Commerical Series, ESP-40SAT-W, Maxicom Central Irrigation controller by Rain Bird.

C. Ethernet Communication:
   1. Approved Products:
      a. RBDS-SEMET by Rainbird

D. Pulse Transmitter:
   1. Approved Products:
      a. PT322 by Rain Bird

E. 2-Wire Interface with Maxicom Controller
   1. Approved Products (one of each required):
      a. Tucor TDI
      b. TDI-F

F.

2.08 BACKFILL MATERIALS

A. Pea Gravel: 3/4 x 1/2 inch washed round rock.

B. Sand: Clean, fill sand free of clay, rocks, organic matter, or other deleterious material.

C. Topsoil or Loam: See Section 31 2000 - Earth Moving.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that required utilities and sleeves are available, in proper location, and ready for use. Verify location, type, size, psi, and GPM of existing water lines, meters, and sleeves.

B. Verify that surfaces and structures to receive Work are accurately sized and located, sound, secure, true, complete, and otherwise properly prepared.

C. Verify electrical service and conduit for Irrigation Controller is properly sized and located.

3.02 PREPARATION

A. System layout is diagrammatic. Route piping to avoid plants, ground cover, and structures. If field measurements differ slightly from Drawings modify work for accurate fit. If measurements differ substantially notify Owner's Representative prior to installation.

B. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system and piping to minimize conflict with other work.

C. Coordinate connections to existing irrigation system, including system shut down, new connections, system re-start, and scheduling of new irrigation zone run times with Owner's Representative.

D. Irrigation Head Layout Review: Install flags at locations of irrigation heads and components shown on Drawings. Obtain Owner's Representative's approval and make adjustments to locations as directed. Coordinate marking of pipe trenches and location of valves prior to executing Work.

3.03 CUTTING OF PAVEMENT AND REPAIR

A. Do no cutting of pavement for installation of Work without Owner Representative's approval.

3.04 BACKFLOW PREVENTION DEVICE INSTALLATION

A. Install where shown on Drawings. Follow applicable codes and in accordance with manufacturer's directions when making supply and central control component connections. Coordinate with other trades.

B. Coordinate connection with other trades.

3.05 MASTER VALVE AND FLOW SENSOR INSTALLATION

A. Install where shown on Drawings in accordance with manufacturer's directions when making supply and central control component connections.

3.06 TRENCHING

A. Excavate trenches with uniform bottom and remove rocks and sharp objects to provide firm, even, clean base for pipe. Width of trench to be 1.5 times the outside diamter of the pipe.

B. Trench Depth:

1. Minimum Cover Over Installed Mainline Piping: 24 inches.
2. Minimum Cover Over Installed Lateral Line Piping: 18 inches.
3. Minimum Cover Over Installed Sleeves in Roadway: 24 inches.
4. Minimum Cover Over Installed Sleeves at other paving: 6 inches from bottom of paving.

C. More than one pipe is permitted in the same trench provided that:

1. Two pipes may be stacked vertically if 4 inches of Sand separates them.
2. Three or more pipes must be laid 4 inches apart horizontally.

D. Where excavation is performed to excess levels backfill with Sand to proper levels.

E. Keep trenches dry and frost free. Provide and operate pumping equipment to keep excavations free from standing water.

F. Protect existing vegetation to remain. Cut no roots over two inches in diameter without approval of Owner's Representative. Make cuts clean, straight, at right angles to roots. Paint cuts over 1-1/2 inches diameter with approved tree paint. Repair or replace damaged plant material.

3.07 SLEEVE INSTALLATION

A. Sleeves may be jacked or pulled but cover requirements must be maintained. Jacking of PVC pipe is not permitted in rocky or bar run fills where there is potential for damage to pipes.

B. Extend sleeves 12 inches beyond pavement edge or curb.

C. Install level and perpendicular to sidewalks and pavement unless shown otherwise on drawings.

D. Provide markers where sleeve ends are concealed.

3.08 PIPE BEDDING

A. Mainline: Provide uniform bearing surface of Sand, 4 inches minimum depth, free of rocks and sharp objects under entire length of pipe.

B. Lateral Line: Provide uniform bearing surface of clean topsoil, loam, or Sand. If rock or other deleterious materials are encountered bed pipe with 4 inches of Sand on all sides.

3.09 PIPE INSTALLATION

A. Irrigation lines may be jacked or pulled but cover requirements must be maintained. Jacking of PVC pipe is not permitted in rocky or bar run fill or where there is potential damage to pipes.

B. Install pipe in accordance with manufacturer's instructions and with the following minimum clearances around pipe:

1. 2 inch diameter and smaller: 2 inches
2. 2-1/2 inch diameter and larger: 4 inches
3. Between irrigation and other utilities: 1 foot

C. Threaded Plastic Pipe Installation:

1. Do not use solvent cement on joints.
2. Wrap threaded joints with teflon tape. Minimum 4 wraps of tape.

D. Cemented Plastic Pipe Installation:

1. Cut ends square using approved pipe cutter and bevel cuts with deburring tool.
2. Clean pipe of scale, sand, dirt, etc. prior to assembling.
3. Avoid using an excess amount of primer and cement when making joints; particularly on the inside of female pipe ends and fittings.
4. Wipe off excess cement continuously as it appears on the surface of the pipe after making joints.
5. Allow fifteen minutes of cure time on joints before moving or handling. Assemble pipe before lowering into trench.
6. Snake lines to allow for contraction.
7. Transition pipe sizes at fittings and not bell end of pipes.
8. Install thrust blocks at 90 degree corners and tees.

3.10 THRUST BLOCK INSTALLATION

A. Install 2500psi thrust block at pipe corners, tees, ells, and stub outs.

1. Pipe 2 - 3 inches in diameter: 1 cubic foot.

3.11 VALVE INSTALLATION

A. Install plumb and square, as detailed, and according to manufacturer's specifications.

B. Manual Drain Valves:

1. Install at mainline low points and at outlet of control valves where laterals run uphill.

2. Record locations on as-built drawings.

C. Install 1 valve in each valve box assembly.

D. Valve Sump: Install a minimum of 2 cubic feet of Pea Gravel below each valve. Allow for 4 inches clearance between bottom of valve and valve sump.

3.12 VALVE BOX INSTALLATION

A. Install plumb and square with adjacent construction with one valve in each valve box assembly.

B. At Control Valve Assemblies bolt two valve boxes together as detailed.

C. Permanently label valve type and zone number on inside of valve box lid.

D. Set top of valve boxes flush with lawn or mulch at plant beds unless otherwise noted.

E. Provide 12 square inches (min.) of support on each side of valve box as detailed.

3.13 CONTROL WIRE INSTALLATION

A. Install wires below irrigation mainline with multiple wires bundled together at 5 foot maximum intervals in a continuous run. Notify Owner's Representative for approval prior if splices are required and locate in valve box.

B. All splices to use 3M DBR/Y gel-filled splices.

C. Use different colored wire for each branch of 2-Wire path.

D. Use coded and labeled wires for each valve. Provide a numbered tag at each end of a wire at valve, and at controller. The number at each end of wire to be the same.

E. Provide 48 inches loop in wires at each valve where controls are connected and at 100 foot maximum intervals between. Coil wire around 1/2 inch rebar dowel inside of valve box.

F. Make electrical joints waterproof using specified connectors. Enclose joints in valve boxes.

G. Install wire in continuous runs with no splices unless approved.

H. Install and ground surge protection every 500 LF and at end of wire run.

I. Show wire routes and approved splice locations on As-Built drawings.

J. Install wires above grade or independent of the mainline in conduit.

3.14 IRRIGATION CONTROLLER ASSEMBLY INSTALLATION

A. Contractor to use Tucor factory-authorized representative provide control panel assembly with TDI and ESP satellites installed or contract with 4J School District Central Control Technician: Water Wise, Rick Wagner (503-381-6282)

B. Ethernet communication (SEMET) shall be coordinated and installed by 4J School District Central Control Technician: Water Wise, Rick Wagner (503-381-6282).

3.15 MAINLINE PRESSURE TEST AND INSPECTION

A. Field inspection and testing will be performed under provisions of Section 01 4000.

B. Prior to backfilling and installing valves test irrigation mainline for leakage. Establish and maintain 100 psi (690 kPa) pressure for 24 hours. Perform test a minimum of 24 hours after set-up of solvent weld. Notify Owner's Representative a minimum of 24 hours for review of pressure gauge at beginning and end of test period. Mainline will be accepted if pressure loss is less than 2 psi.

C. Following the pressure test but prior to backfilling, notify Owner's Representative for review of pipe, fittings, joints, thrust blocks, bedding, control wire installation, valves, and other materials for installation and water tightness.

D. After successful pressure test and mainline inspection begin backfilling and assembly of zones and system components.

3.16 BACKFILLING

A. Remove debris, sharp rocks, and decayable matter from areas to be back filled before proceeding.

B. Main Lines: Provide 6 inch Sand cover over piping then place Utility Locate Wire the entire length of pipes where control wires are not present. Backfill remainder of trench with Topsoil or Loam.

C. Lateral Lines: Backfill trench with Topsoil or Loam. Protect piping from displacement.

D. At Paved Areas: Backfill trench with Sand under paved areas.

E. Compact backfill in 6 inch lifts to match density of surrounding material. Install backfill to match adjacent elevations.

3.17 FLUSHING

A. Mainline: Open valves and thoroughly flush piping system under full water head after piping, risers, and valves are installed. Maintain flushing for three minutes. Close valves and cap risers immediately after flushing.

B. Second Flushing: Flush a second time after installation of lateral lines and sprinklers prior to nozzle installation. Flush under full water head for three minutes. Install nozzles after flushing.

3.18 SPRINKLER HEAD INSTALLATION

A. Install plumb with top of Topsoil/Loam or Mulch as detailed and at locations shown on drawings. Allow a maximum of 3 inches clearance between sprinkler head and adjacent lawn or planting edge.

B. Install 1 cubic foot Pea Gravel sump on all low irrigation heads where drainage occurs at zone shutdown.

3.19 SYSTEM REVIEW

A. Prepare and start system in accordance with manufacturer's instructions. Prior to notifying Owner's Representative for review of the system review zones and make adjustments to ensure full and even coverage.

B. Notify Owner's Representative for review of system operation to determine if water afforded to all areas is complete, adequate, and uniform.

C. Final acceptance with operation of system by Maxicom Central Control to be coordinated with 4J School District Central Control Technician: Water Wise, Rick Wagner (503-381-6282)

D. Adjust system for full water coverage as directed.

3.20 SYSTEM DEMONSTRATION TO OWNER

A. Instruct Owner's personnel in operation and maintenance of system, including adjusting of sprinkler heads. Use operation and maintenance data as basis for demonstration.

3.21 CLEANING

A. Remove excess excavation, backfill materials, and other left over materials from the site. Clean improvements soiled by Work of this Section.

END OF SECTION

SECTION 32 9000
PLANTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preparation of subsoil.
B. Soil Material placement.
C. New trees, plants, and ground cover.
D. Mulch and Fertilizer.
E. Maintenance.

1.02 RELATED REQUIREMENTS

A. Section 01 5639 - Temporary Tree and Plant Protection.
B. Section 01 6000 - Product Requirements.
C. Section 01 7000 - Execution and Closeout Requirements.
D. Section 31 2000 - Earth Moving.
E. Section 32 8000 - Irrigation.

1.03 DEFINITIONS

A. Weeds: Any plant life not specified or scheduled. Includes seeds and roots.
B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

1.04 REFERENCE STANDARDS

A. Quality definitions, grading tolerances, root system condition, caliper height, branching, budding: ANSI/ANLA Z60.1 - American Standard for Nursery Stock, latest edition.
B. ANSI A300 Part 1 - American National Standard for Tree Care Operations -- Tree, Shrub and Other Woody Plant Maintenance -- Standard Practices; 2001.
C. Nomenclature conforms to "Standardized Plant Names," 1942 Edition, published by J. Horace McFarland Co., or "New Sunset Western Garden Book," listed in these references are those used most commonly in the nursery trade.

1.05 PROTECTION

A. Protect existing improvements and growth in areas to remain undisturbed until completion of project. Leave in similar condition as found.
B. Maintain benchmarks, monuments, and other reference points. Replace if disturbed or destroyed.
C. Contact local utility companies for verification of the location of underground utilities within the project area prior to starting excavation. Protect utilities and maintain in continuous operation or in operational condition during work. Repair damage to known utilities or related facilities in an approved manner at Contractor's expense.
D. Protect drainage inlets and underground drain lines from infiltration or clogging by soils and mulch during construction until Final Completion.
E. Protect materials of this Section before, during, and after installation. Protect installed work and materials of other trades. In the event of damage immediately make repairs or replacements as directed by Owner's Representative.

1.06 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Maintenance Data: Include written instructions covering yearly recommended maintenance and care of plantings including fertilization, pest and disease control, weed control, mulching, and pruning.

C. Quality Assurance Data: Submit license information and project references including name and location of previous projects, date of installation, square footage of areas with planting work, and Owner's contact information.

D. Submit list of plant life sources within 14 calendar days of Agreement Date.

1. Submit confirmation from supplier(s) that specified plant materials, meeting the specifications, have been secured.
2. Include plant name, quantity, size, condition, and name of supplier.
3. Submit certification letter from the sod supplier(s) stating the sod has been secured or contracted for delivery. Include the quantity, grass mix, and description.

E. Product Data: Submit manufacturer's printed data for products and a list of suppliers.

F. Sample: Submit a 2 quart sample of Soil Material with supplier's name and specific location of source. Approval of Soil Material by Owner’s Representative is required prior to delivery to the site.

G. Invoices: Within 2 days of delivery submit invoices, load tickets, and truck measures for Organic Material and Mulch.

1.07 QUALITY ASSURANCE

A. Valid Oregon Landscape Contractor's license.

B. Valid Oregon Landscape Business license.

C. Installer Qualifications: Company specializing in installing and planting the plants with 5 projects of comparable scale successfully completed.

1. Submit names, addresses, and dates of previous projects, owners.

1.08 COORDINATION

A. Coordinate with other trades affecting and affected by Work of this Section.

B. Pre-Installation Conference: Attend conference to coordinate Work of this Section and other related Sections.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

B. Protect and maintain plant life until planted.

C. Deliver plant life materials immediately prior to placement. Keep plants moist.

D. Deliver products in original unopened packaging with legible manufacturer's identification.

E. Seed containers shall show manufacturer's guaranteed analysis of seed mixture, percentage of purity, year of production, date and location of packaging, name and trademark, and conformance with governing regulations.

F. Plants may be rejected if:

1. Ball of earth surrounding roots has been dried out, cracked, or broken.
2. Burlap, staves, wire baskets, or ropes required in connection with transplanting have been displaced.
3. Grower or nursery identification labels have been displaced prior to acceptance.

1.10 ENVIRONMENTAL CONDITIONS

A. Do not install plant life and seed when ambient temperatures is below 32 degrees Fahrenheit or above 90 degrees Fahrenheit

B. Do not install plant life when wind velocity exceeds 30 mph.

C. Do not install plant life when soil becomes saturated.

D. Install plant materials and seed during periods which are normal for such work as determined by the following:

1. Biological season
2. Specified environmental conditions
3. Accepted practice
4. After all major construction work has been completed

E. Planting Seasons:

1. Trees: Bare root trees may be planted only between January 15th and March 15th unless otherwise approved.
2. Seeding: Permitted between April 15 and October 15 unless otherwise approved.
3. Other: Permitted during any period, except when prohibited by other portions of this Section.

1.11 REVIEWS

A. Request the following reviews by the Owner's Representative 2 days in advance:

1. Subgrade preparation
2. Soil Material placement
3. Organic Material placement
4. Finish grading
5. Plant materials
6. Plant material layout
7. Planting mock-up
8. Completion

B. See Part 3 - Execution for review requirements.

C. Coordinate all reviews to coincide with regular progress meetings where possible.

1.12 RECORD DOCUMENTS

A. See Section 01 7800 - Closeout Submittals

B. Produce, keep current, and submit legible record documents on a clean set of plans and details supplied by the Owner's Representative. Use white-out and red ink to legibly re-draft actual locations of installed work.

1.13 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide one year warranty following Final Completion or one full growing season following Final Completion, whichever is later.

C. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

D. Inspection: Visit work at least once a month during warranty period. Notify Owner's Representative and Owner in writing of any observed conditions requiring attention. Failure to provide such notification renders any deficiencies the Contractor's responsibility to rectify.

E. At the end of the warranty period, as directed by Owner's Representative and at no additional cost to the Owner:

1. Replace work not surviving, in poor condition, or not exhibiting satisfactory growth.
2. Lawns must be healthy, dense, uniform, well-sodded, and reasonably weed free as judged by the Owner's Representative.
3. Reset plant materials and stones which have settled or become un-set
4. Replace plant materials which appear to be a different species or variety than specified.
5. Provide noxious weed eradication from imported Soil Material, if required and as specified herein.
6. Complete warranty work within 30 days of warranty review.

F. Contractor is not responsible for plant loss or damage to work during warranty period which is caused by unusually extreme weather, vandalism, or Owner's lack of maintenance.

PART 2 PRODUCTS

2.01 PLANTS

A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

B. General:

1. Sizes, grades, and conditions are listed on Plant List. Quantities are shown for Contractor's convenience. Contract is responsible for providing plants drawn on drawings.
2. Cold storage stock unacceptable.
3. Free of disease, decay, injury, insects, or indication of strawberry root weevil.
4. Full foliaged when in leaf.
5. Furnish balled and burlapped (B&B) stock with solid, properly wrapped and secured, natural ball. Stock 2 inch caliper and up to be transported and handled with root ball in wire basket.
6. Furnish container stock with sufficient roots to insure healthy growth but not root bound. When plant is removed from container soil must hold together and roots must be visible but not encircling.
7. Free from Weeds.
8. Field grown trees and shrubs must have been transplanted or root pruned at least once no more than two years prior to this Contract.
9. Container stock may be substituted for Balled and Burlapped (B&B) stock at any time.

C. Trees shall have:

1. Single, straight, uniformly tapering trunks which are perpendicular to the ground, unless specified as multi-stemmed or otherwise on Plant List. Trees with co-dominant, damaged, crooked, or topped leaders will be rejected.
2. Healthy and vigorous overall condition.
3. Full and even branch distribution; structural scaffold branches at least 4 inches apart where they attach to the main trunk.
4. Well developed root systems. Trees with more than 2 inches of root ball soil covering root flare will be rejected.
5. Grafts near ground level.
6. Minimum/maximum branching heights above the ground unless specified otherwise on Plant List:
   a. 2 inch caliper tree: 5' - 7'
   b. 1.5 inch caliper tree: 4' - 6'
7. Conifers shall also have full, even branching to ground level and intact single leader.

8. Trees shall be free of:
    a. Major structural defects including, but not limited to, branches with narrow angle of attachment (less than 40 degrees to the trunk), bark with major branch unions, and trees with co-dominant leaders.
    b. Poor pruning practices including, but not limited to, stubbed branches and topped leader.
    c. Damage to the trunk, branches, and root system including, but not limited to, bark abrasions, sun scald, and disfiguring knots.
9. Trees shall be freshly dug during the most recent favorable harvest season.

2.02 SOIL MATERIALS

A. Planting Soil: On-site soil, natural, fertile, friable, with at least 10% humus; free of rock, clay, subsoil, clods, lumps, plants, roots, sticks, weeds, seeds, and other deleterious material, as approved.
1. At Plant Beds:
    a. Primary Planting Soil by Rexius Forest By-Products, Eugene, Oregon.
    b. Frugal Planting Soil by Lane Forest Products, Eugene, Oregon.
2. At Grassy Swale Stormwater Planters:
    a. See Specification Section 31 2000 for soil and compost.
3. At Lawns:
    a. Primary Planting Soil by Rexius Forest By-Products, Eugene, Oregon.

2.03 SOIL AMENDMENT MATERIALS

A. Lawn Installation Fertilizer: Uniform composition, dry, and free flowing of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:
1. Nitrogen: 16 percent. (source of Nitrogen to be methyl-urea based)
2. Phosphoric Acid: 16 percent.
3. Soluble Potash: 16 percent.
4. Do not use within 50 feet of water.

B. Lawn Maintenance Fertilizer: Uniform composition, dry, and free flowing of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:
1. Nitrogen: 25 percent. (30% Nitrogen from slow release)
2. Phosphoric Acid: 5 percent.
3. Soluble Potash: 10 percent.
4. Do not use within 50 feet of water.

C. Plant Bed Maintenance Fertilizer: Uniform composition, dry, and free flowing of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:
1. Nitrogen: 16 percent. (Source of Nitrogen to be methyl-urea based)
2. Phosphoric Acid: 16 percent.
3. Soluble Potash: 16 percent.
4. Do not use within 50 feet of water.

D. Planting Tablets:
1. Product: Sierra Chemical "Agriform" with 20-10-5 chemical analysis.
2. Substitutions: See Section 01 6000 - Product Requirements.

E. Micorrhizal Fungi:
1. MycroApply® All Purpose Granular by Micorrhizal Applications Inc, Grants Pass, Oregon (541-476-3985).
2. Substitutions: See Section 01 6000 - Product Requirements.

F. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.

G. Organic Material: 100% organic materials following guidelines and tested to meet the US Composting Council's seal of testing assurance.

1. Products: Garden Compost by Rexius Forest Byproducts, Eugene, Oregon.

H. Top Dressing: Turf Start by Rexius Forest Byproducts, Eugene, Oregon, or approved.

2.04 GRASSY SWALE INLET ROCK

A. River cobblestones of 3 distinct sizes:

Large	7-9 inches
Medium	5-7 inches
Small	3-5 inches

B. Cobblestones to be washed clean and free of broken faces.

C. Products:

1. Cobblestone by Lane Forest Products, Eugene, Oregon.
2. Substitutions: See Section 01 6000 - Product Requirements.

2.05 GRASS SEED

A. Certified Oregon Blue Tag Free of Weed seed with dealer's statement analysis guarantee.

B. Current or latest season's crop labeled in conformance with State and US Department of Agriculture laws and regulations:

1. Purity: 98% by weight
2. Germination: 90%

C. Products:

1. Finish Lawn - Type A and Type B and Lawn Repair Seed:
   a. Futura 3000 by Pickseed, Tangent, Oregon
2. EcoLawn Seed:
   a. PT 705 Xeriscape by Pro Time Lawn Seed, Portland, Oregon.
3. Grassy Swale Seed:
   a. PT 442 BES Grassy Swale Native Mix by Pro Time Lawn Seed, Portland Oregon

2.06 MULCH MATERIALS

A. Mulching Material: Hemlock species wood shavings, free of growth or weeds, "sliver free".

1. Products: Hemlock Bark by Rexius Forest Byproducts, Eugene, Oregon, or Lane Forest Products.

2.07 ACCESSORIES

A. Wrapping Materials: Burlap.

B. Stakes: 2 x 2 inch x 8 feet wood stakes, capable of at least 2 years ground burial, stained charcoal or black.

C. Tree Ties: Chain lock tree ties, 1 inch wide, or approved.

2.08 HERBICIDE

A. No herbicide use allowed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to installation of Work of this Section, carefully inspect the work of others and verify that such work is complete to the point where this installation may properly commence.

B. Verify that materials and surfaces to receive work specified herein are accurately sized, shaped, and located; sound, secure, true, complete, and otherwise properly prepared.

C. Verify subgrades produce positive drainage and allow for placement of Soil Material, Amendments, and Mulch to specified depths.

D. Do not install Work of this Section until all unsatisfactory conditions have been corrected. Beginning Work of this Section signifies acceptance of existing conditions.

3.02 TOLERANCES

A. Perform earthwork true to lines and grades, and to prevent ponding of water, with maximum variation in elevations of +/- 1/2 inch at subgrades and +/- 1/4 inch at finish grades.

B. Compacted thickness of materials within 1/4 inch of specified thickness.

3.03 PREPARATION OF SUBGRADE

A. Prepare subsoil to eliminate uneven areas or low spots. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds and undesirable plants and their roots, stones, rock, and dirt clods. Remove contaminated subsoil.

C. Scarify subsoil to a depth of 6 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

D. Verify subgrades, whether comprised of subgrade soil or fill drain freely. Test area by flooding with Owner's Representative present. Where water does not drain freely auger a 10 inch hole, minimum 1 per 1,000 square feet, through fill material and into subsoil, or maximum 4 feet deep into subsoil to establish positive drainage.

E. Verify subgrades allow for placement of Soil Material, Amendments, and Mulch to depths specified.

F. Notify Owner's Representative for Subgrade Preparation Review prior to placing Soil Material.

3.04 PLACING SOIL MATERIAL

A. Soil Placement Schedule:

1. At Plant Beds: 18 inches minimum depth.
2. At Finish Lawn - Type A, and EcoLawns: 9 inches minimum depth.
3. At Grassy Swales: Refer to Specification Section 31 2000. 12" minimum.
4. At Lawn Repair: Additional Soil as necessary to fill in depressions, belnd grades and produce positive drainage
5. Place additional Soil Material as required to establish finish grades shown on drawings and to fill in depressions, blend grades, and produce positive drainage.

B. Place Soil Material during dry weather and on dry unfrozen subgrade. Suspend Soil Material placement if subgrade or Soil Material become saturated.

C. Phase Soil Material placement so that equipment does not travel over Soil Material already installed.

D. Place Soil Material in a relatively dry state to depths specified at locations shown on Drawings:

1. Remove stones, roots, grass, weeds, debris, and foreign material while spreading.
2. Manually spread around existing trees, paving, and other structures to prevent damage.
3. Establish levels, profiles, slopes, contours, and uniform gradients between given grade points as shown on Drawings.

4. Eliminate uneven or low spots at lawns and plant beds.
5. Fine grade Soil Material within specified tolerances.

E. Notify Owner's Representative for Soil Material Placement Review prior to proceeding with Work.

3.05 INITIAL WEED CONTROL

A. Inspect plant beds, lawns, and erosion control grass areas for the presence of weeds. If weeds are present manually remove.

3.06 SOIL PREPARATION AND FINISH GRADING

A. Remove debris, sticks, roots, clods, stones, and soils contaminated by petroleum products at plant beds and lawns. Rake smooth, eliminate uneven areas or low spots in Soil Material, and set grades for positive drainage.

B. At plant beds:
1. Manually remove weeds as described in Initial Weed Control.
2. Spread 3 inches Organic Material over entire plant bed. Organic Material must be incorporated immediately into plant beds, no stock piling is permitted.
3. Notify Owner's Representative for Organic Material Placement Review prior to proceeding with tilling and planting.
4. Thoroughly rototill Organic Material into the top 6 inches of Soil Material, except within 10 feet of existing trees and Tree Protection zones where plants will be pocket planted.
5. Rake smooth and reset finish grades eliminating uneven or low spots in plant beds and setting grades for positive drainage. Ensure grades at edges of plant beds allow for placement of Mulch Material to specified depths and as detailed.

C. At trees:
1. Thoroughly mix 5 parts Soil Material and 1 part Organic Material for backfilling trees.

D. At Finish Lawn-Type A, EcoLawn, and Grassy Swale:
1. Manually remove weeds as described in Initial Weed Control.
2. Spread Lawn Installation Fertilizer at the rate of 15 lbs per 1000 square feet. If a Terraseeding method is used for lawn installation do not apply Lawn Installation Fertilizer.
3. Rototill to a minimum depth of 4 inches, except within 10 feet of existing trees and Tree Protection zones.
4. Set finish grades to ensure that finish grade of lawn will be flush with surrounding surfaces.
5. Establish a friable, fine textured seed bed free of bumps and depressions immediately before seeding.
6. Firm seed bed with a lawn roller making passes in 2 directions.

E. At Finish Lawn-Type B and Lawn Repair areas:
1. Manually remove weeds as described in Initial Weed Control.
2. Place additional Soil Material as necessary to fill in depressions and blend grades with surrounding lawns, plant beds, and paving.
3. Set finish grades to ensure that finish grade of lawn will be flush with surrounding surfaces.
4. Establish a friable, fine textured seed bed free of bumps and depressions immediately before seeding.
5. Firm seed bed with a lawn roller making passes in 2 directions.
6. Spread Lawn Installation Fertilizer at the rate of 15 lbs per 1000 square feet. If a Terraseeding method is used for lawn installation, do not apply Lawn Installation Fertilizer.

F. At lawns in Tree Protection Zones:
   1. Strip existing sod and remove from site.
   2. Manually remove weeds as described in Initial Weed Control.
   3. Core aerate with a minimum of 3 passes.
   4. Place additional Soil Material as necessary to fill in depressions and blend grades with surrounding lawns, plant beds, and paving.
   5. Set finish grades to ensure that finish grade of lawn will be flush with surrounding surfaces.
   6. Establish a friable, fine textured seed bed free of bumps and depressions immediately before seeding.
   7. Firm seed bed with a lawn roller making passes in 2 directions.
   8. Spread Lawn Installation Fertilizer at the rate of 15 lbs per 1000 square feet. If a Terraseeding method is used for lawn installation do not apply Lawn Installation Fertilizer.

G. Notify Owner's Representative for Finish Grading Review prior to proceeding with Work.

3.07 SECOND WEED CONTROL

A. After completion of Soil Preparation and finish grading commence irrigation of all plant beds, lawns, and erosion control grass areas. If weeds are present manually remove.

3.08 INSTALLATION OF PLANT MATERIAL

A. Plant Material Review: Notify Owner's Representative prior to the delivery of all trees and plant materials to the site and prior to installing plants. Owner's Representative will review quality of plant materials and reject plant materials not in compliance the Plant List and Specifications. This review is preliminary. Final approval of plants materials will not be given until Completion Review.

B. Plant Material Layout Review: Layout plant material (in containers or B&B) at plant beds for review prior to installation. Notify Owner's Representative for review of plant material layout prior to commencement of planting. The plant material layout review may occur concurrently with the planting mock-up review. Adjust plant materials as directed.

C. Planting Mock-Up Review: Notify Owner's Representative prior to commencement of planting. Install an initial 500 square feet sample of typical plantings for review. Adjust planting procedure as directed.

D. Tree Planting:
   1. Soak container grown, B&B, and BR plants before planting.
   2. Remove extra soil on top of root ball to expose flare of first buttress root. Root flare must be visible at top of root ball.
   3. Dig individual planting holes circular with vertical sides as shown on Planting Detail.
   4. Save and thoroughly loosen soil removed from planting hole and use as backfill around tree. Backfill trees with specified mixture if additional Soil Material is needed.
   5. Sprinkle micorrhizal fungi to surface of planting holes at rate of 2-4 ounces per inch of stem caliper.
   6. Lift trees by wire basket only. Do not lift trees by trunk or use trunk as a lever to position or move tree.
   7. Set B&B trees in the hole with the north marker facing north unless otherwise approved.
   8. Set root crown as shown on Planting Detail not less than 3 inches above surrounding finish grade.
   9. Cut and completely remove twine and other fasteners from root ball. Remove burlap from top half of root ball. Remove all burlap if not biodegradable. Neatly cut off broken or frayed roots.
   10. Remove top half of wire basket after planting.

11. Stake trees as shown on Planting Detail.

E. All other Plants:
   1. Soak container grown, B&B, and BR plants before planting.
   2. Dig individual planting holes with circular and with vertical sides 1-1/2 inch shallower than depth of root ball.
   3. Dig holes for pocket-planted shrubs 3 times the diameter of the rootball.
   4. Sprinkle micorrhizal fungi to surface of planting holes at the following rates:
      a. #SP4 container - 1 tablespoon
      b. #1 container - 2 tablespoons
      c. #3 container - 3 tablespoons
      d. #5 container - 5 tablespoons
   5. Install Planting Tablet at shrubs and ground covers at manufacturer's recommended high rate.
   6. Cut circling roots with a sharp knife.
   7. Set root crowns 1-1/2 inch above surrounding grade and as detailed.
F. Plants set too deeply will be rejected. Reset plants that have settled.
G. Set Plants plumb and for best appearance.
H. Carefully tamp soil under and around root balls and bare roots to prevent settlement.
I. Backfill pocket-planted plants with equal parts Soil Material and Organic Material.
J. Flood hole when half backfilled and tamp soil between bare roots.
K. Complete backfilling and tamp soil between bare roots.
L. Thoroughly water each plant and entire bed immediately after planting.
M. Remove all tags, labels, strings, etc. from plants.
N. Prune Plant Material to remove dead, broken, or damaged branches.
O. Rake plant beds smooth, resetting finish grades for positive drainage and eliminating uneven or low spots.
P. Bulb Planting:
   1. Dig individual holes to the depth, size, and spacing scheduled on the Plant List.
   2. Place one teaspoon of Installation Fertilizer and work into soil. Place bulb and backfill soil.
   3. Cover entire area shown on Drawing as Mulch Area with Perennial Bulbs with 3 inches Organic Material as a mulch.

3.09 MULCH INSTALLATION

A. Install mulch within 24 hours after planting at plant beds and trees as shown on drawings and details at the following depths:
   1. Hemlock Bark: 3 inches
B. Remove excess Mulch from foliage of plant materials and from bark of trees. Mulch must not be placed within 3 inches of tree trunks. Remove mulch from adjacent surfaces and produce edges shown on Details.

3.10 LAWN AND ECO LAWN INSTALLATION

A. Install lawns and eco lawns using one of the following methods:
   1. Hand seeding:
      a. Apply seed evenly at rate of 6 lbs per 1000 square feet at Finish Lawn-Type A and Type B, and Grassy Swale and at 87 lbs per acre at EcoLawn.
      b. Apply Lawn Installation Fertilizer at a rate of 15 lbs per 1000 square feet.

c. Rake lightly to a depth of 1/16 inch.
d. Roll seeded area with half full lawn roller.
e. Apply approved mulch as necessary to keep areas moist during germination.

2. Terraseeding:
a. Apply a 1 inch layer of Top Dressing injected with the following:
1) Seed: 8 lbs per 1000 square feet at lawns or per manufacturer's specifications and 87 lbs per acre at eco lawn.
2) Lawn Installation Fertilizer: 15 lbs per 1000 square feet.
b. Do not install Top Dressing within mulch circles at trees.
c. Approved Installer: Rexius Forest Byproducts, Eugene, Oregon, or approved.

B. Apply water with fine spray immediately after each area is sown.

3.11 TREE PRUNING

A. Perform pruning of trees as recommended in ANSI A300.
B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.12 MAINTENANCE

A. At Plant Beds during period between installation and Final Completion:
1. Water, fertilize, weed, reset unstable or disturbed plants, and perform other maintenance necessary to assure healthy growth.
2. Install Plant Bed Maintenance Fertilizer at a rate of 6 lbs per 1000 square feet 45-60 days after installation. Adjust timing for seasonal requirements of plant materials.
3. Thoroughly water immediately after applying Plant Bed Maintenance Fertilizer.
4. Repair and regrade erosion damage .
5. Provide continued weed control and removal until any weed problem is fully eradicated.

B. At Finish Lawn-Type A and Type B and Lawn Repair areas, during period between installation and Final Completion:
1. Water, weed, mow, reseed, top dress, and fertilize as necessary to establish a healthy, dense, uniform, weed free stand of grass; maintain at 2 inches high. This includes unirrigated lawns, unless otherwise noted on drawings.
2. Conduct first mowing after grass is firmly rooted and secure. Mow grass when it exceeds 2 inches in height, cutting no more than 1/3 of the grass height at a time. Remove all clippings.
3. Maintain surfaces and supply additional Soil Material and Seed where necessary.
4. After first mowing apply Lawn Maintenance Fertilizer at a rate of 8 lbs per 1000 square feet. Thoroughly water after application.
5. Manually remove weeds.

C. At EcoLawn between installation and final completion:
1. Water, weed, mow, reseed, top dress, and fertilize as necessary to establish a healthy, dense, uniform, weed free stand of grass.
2. Maintain surfaces and supply additional Soil Material and Seed where necessary.
3. Manually remove weeds.

D. At Grassy Swale between installation and final completion
1. Water, weed, reseed, and fertilize as necessary to establish a healthy, dense, uniform, weed free stand of grass.
2. Maintain surfaces and supply additional Soil Material and Seed where necessary.
3. Manually remove weeds.
4. Rest unstable or disturbed plants.

3.13 CLEANING

A. Remove excess materials from site. Protect drain inlets and underground piping as necessary and clean improvements soiled by Work of this Section.

3.14 COMPLETION REVIEW

A. Notify Owner's Representative for Completion Review when Work of this Section is complete.

END OF SECTION

SECTION 33 11 00
WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service, fire-service mains, and combined water service and fire-service mains.

B. Utility-furnished products include water meters that will be installed by the utility company.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Valves and accessories
   2. Backflow preventers, assemblies, vaults and enclosures.
   3. Fire hydrants.
   4. Fire department connections.
   5. Pipe.

B. Field quality-control test reports.

C. Operation and maintenance data for the following:
   1. Water meters
   2. Valves
   3. Backflow preventers
   4. Hydrants

D. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements of EWEB. Include tapping of water mains and backflow prevention.
   2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
   3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

F. NSF Compliance:
   1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
   2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.4 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
   1. Notify Architect no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of water-distribution service without Architect's written permission.

1.5 COORDINATION

A. Coordinate connection to water main with EWEB.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Gaskets: AWWA C111, rubber.

C. PVC, AWWA Pipe: AWWA C900, Class 150 and Class 200, with bell end with gasket, and with spigot end.
   1. Comply with UL 1285 for fire-service mains if indicated.
   2. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      a. Gaskets: AWWA C111, rubber.

2.2 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8, BCuP Series.

B. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

C. Soldering Flux: ASTM B 813, water-flushable type.

D. Solder Filler Metal: ASTM B 32, lead-free type with .20 percent maximum lead content.

2.3 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:
   1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
      a. Standard: AWWA C219.

2.4 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. American AVK Co.; Valves & Fittings Div.
      b. American Cast Iron Pipe Co.; American Flow Control Div.
      c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
      d. Crane Co.; Crane Valve Group; Stockham Div.
      e. East Jordan Iron Works, Inc.
      f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
      g. McWane, Inc.; Kennedy Valve Div.
      h. McWane, Inc.; M & H Valve Company Div.
      i. McWane, Inc.; Tyler Pipe Div.; Utilities Div.
      j. Mueller Co.; Water Products Div.
      k. NIBCO INC.

l. U.S. Pipe and Foundry Company.

2. Nonrising-Stem, Resilient Wedge Gate Valve:
   a. Description: ductile iron body bonnet and wedge. The wedge shall be encapsulated in rubber.
      1) Standard: AWWA C515.
      2) Minimum pressure rating: 200 psig.
      3) End Connections: Mechanical joint.
      4) Interior coating: Complying with AWWA C550.
3. OS&Y, Rising Stem, Resilient-Seated Gate Valves.
   a. Description: Ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
      1) Standard: AWWA C515.
      2) Minimum Pressure Rating: 200 psig.
      3) End Connections: Mechanical joint.
      4) Interior Coating: Complying with AWWA C550.

B. UL/FMG, Cast-Iron Gate Valves:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. American Cast Iron Pipe Co.; American Flow Control Div.
      b. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
      c. Crane Co.; Crane Valve Group; Stockham Div.
      d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).McWane, Inc.; Kennedy Valve Div.
      e. McWane, Inc.; M & H Valve Company Div.
      f. Mueller Co.; Water Products Div.
      g. NIBCO INC.
      h. U.S. Pipe and Foundry Company.
   2. UL/FMG, Nonrising-Stem Gate Valves:
      a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.
         1) Standards: UL 262 and FMG approved.
         2) Minimum Pressure Rating: 175 psig.
         3) End Connections: Flanged.
   3. OS&Y, Rising-Stem Gate Valves:
      a. Description: Iron body and bonnet and bronze seating material.
         1) Standards: UL 262 and FMG approved.
         2) Minimum Pressure Rating: 175 psig.
         3) End Connections: Flanged.

C. Bronze Gate Valves:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Div.
      d. Hammond Valve.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Red-White Valve Corporation.
   3. OS&Y, Rising-Stem Gate Valves:
      a. Description: Bronze body and bonnet and bronze stem.
         1) Standards: UL 262 and FMG approved.

2) Minimum Pressure Rating: 175 psig.
3) End Connections: Threaded.

4. Nonrising-Stem Gate Valves:
   a. Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.
      1) Standard: MSS SP-80.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
   1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

B. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.6 WATER METERS

A. Water meters will be furnished and installed by EWEB.

2.7 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ames Fire & Waterworks; a division of Watts Regulator Co.
      b. Conbraco Industries, Inc.
      c. FEBCO; SPX Valves & Controls.
      d. Flomatic Corporation.
      e. Watts Water Technologies, Inc.
      f. Wilkins; a Zurn company.
   2. Standard: AWWA C511.
   3. Operation: Continuous-pressure applications.
   4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
   5. Size: 3”
   6. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved; steel with interior lining complying with AWWA C550 or that is FDA approved; or stainless steel for NPS 2-1/2 and larger.
   7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   8. Configuration: Designed for horizontal, straight through flow.
   9. Accessories:
      a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
      b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

B. Double-Check Detector, Backflow-Prevention Assemblies:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ames Fire & Waterworks; a division of Watts Regulator Co.
      b. Conbraco Industries, Inc.
      c. FEBCO; SPX Valves & Controls.
      d. Flomatic Corporation.
      e. Watts Water Technologies, Inc.
      f. Wilkins; a Zurn company.
   2. Standard: AWWA C510.
   3. Operation: Continuous-pressure applications, unless otherwise indicated.

4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Size: As indicated on plans
6. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved; steel with interior lining complying with AWWA C550 or that is FDA approved; or stainless steel.
7. End Connections: Flanged.
8. By-pass meter reading: gallons/min.
9. Configuration: Designed for horizontal, straight through flow.
10. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

2.8 WATER METER BOXES

A. Water meter boxes will be furnished and installed by EWEB.

2.9 CONCRETE VAULTS

A. Description: Precast, reinforced-concrete vault, designed for H-20 load designation according to ASTM C 857 and made according to ASTM C 858. Contractor to size vault based on EWEB required clearances and backflow preventers selected.
   1. Vaults shall meet requirements of EWEB.
   2. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.
   3. Hatch: 30” diamond plate aluminum or galvanized steel door.
   4. Drain: Sump pump daylighting to closest curb per EWEB requirements.
      a. Sump pump to have high water alarm. High water alarm to meet EWEB requirements.
      b. Sump pump’s power source to be 115 volt, single phase.
   5. Riser extensions: Provide riser extensions matching vault size as necessary to match proposed grades.

2.10 ABOVE-GROUND BACKFLOW ENCLOSURE

A. Sized to be smallest possible product based on required clearances and backflow preventer selected.
   1. Available manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Hotbox
      b. Strongbox
   2. Insulated or heated to meet EWEB requirements.
   3. Approval of color and type by architect and landscape architect prior to purchase required.

2.11 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. American AVK Co.; Valves & Fittings Div.
      b. American Cast Iron Pipe Co.; American Flow Control Div.
      c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
      d. American Foundry Group, Inc.
      e. East Jordan Iron Works, Inc.
      f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
      g. McWane, Inc.; Kennedy Valve Div.
      h. McWane, Inc.; M & H Valve Company Div.
      i. Mueller Co.; Water Products Div.
      j. Troy Valve; a division of Penn-Troy Manufacturing, Inc.
      k. U.S. Pipe and Foundry Company.

2. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
   a. Standard: AWWA C502.
   b. Pressure Rating: 150 psig minimum.
   c. Outlet Threads: external hose thread used by local fire department. Include cast-iron caps with steel chains.
   d. Exterior Finish: In conformance with local requirements.

2.12 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Elkhart Brass Mfg. Co., Inc.
      b. Fire End & Croker Corporation.
      c. Guardian Fire Equipment, Inc.
      d. Kidde Fire Fighting.
      e. Potter Roemer.
      f. Reliable Automatic Sprinkler Co., Inc.
   2. Description: Exposed, Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high brass sleeve; and round escutcheon plate.
      a. Standard: UL 405.
      b. Connections: Two NPS 2-1/2 inlets and one NPS 4 outlet.
      c. Inlet Alignment: Inline, horizontal.
      d. Finish Including Sleeve: Rough chrome-plated.
      e. Escutcheon Plate Marking: "AUTO SPKR & STANDPIPE."
      f. Exterior Finish: Red or orange OSHA safety colors.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping NPS 4 and NPS 12 shall be any of the following:
   1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
   2. NPS 4 to NPS 12: PVC, AWWA C900 Class 150 pipe; PVC, AWWA Class 150 ductile iron, mechanical-joint fittings; and gasketed joints.

F. Aboveground and vault water-service piping NPS 4 and NPS 6 shall be the following:
   1. Ductile-iron, flanged-end pipe; ductile-iron, flanged-end appurtenances; and flanged joints.

G. Aboveground and vault water-service piping NPS 8 shall be any of the following:
   1. Ductile-iron, flanged-end pipe; ductile-iron, flanged-end appurtenances; and flanges joints.

H. Underground Fire-Service-Main Piping NPS 4 to NPS 8 shall be any of the following:
   1. Ductile-iron, push-on-joint pipe; ductile-iron, mechanical-joint fittings; and gasketed joints.
   2. PE, Class 150 or 200, fire-service pipe; molded PE fittings; and heat-fusion joints.
   3. PVC, AWWA Class 150 pipe listed for fire-protection service; ductile iron fittings; and gasketed joints.
   4. PVC, AWWA Class 200 pipe listed for fire-protection service; ductile iron fittings; and gasketed joints.

I. Aboveground and Vault Fire-Service-Main Piping NPS 4 to NPS 8 shall be ductile-iron, flanged-end pipe; ductile-iron-pipe appurtenances; and flanged joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient - seated gate valves with valve box.
   2. Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
   3. Use the following for valves in vaults and aboveground:
      a. Gate Valves, NPS 2 and Smaller: Bronze, nonrising stem.
      b. Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated or UL/FMG, cast iron, OS&Y rising stem.

3.4 PIPING INSTALLATION

A. Water-Main Connection: Arrange with EWEB for tap of size and in location indicated in water main.

B. Comply with NFPA 24 for fire-service-main piping materials and installation.
   1. Install copper tube and fittings according to CDA's "Copper Tube Handbook."

C. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

D. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.

E. Bury piping with depth of cover over top at least 36 inches, with top at least 12 inches below level of maximum frost penetration.

F. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
   1. Terminate water-service piping at within 5 feet of building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

G. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, mechanical restraints, and other supports.

3.5 JOINT CONSTRUCTION

A. Make pipe joints according to the following:
   1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
   2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
   3. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
   4. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.6 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
   1. Concrete thrust blocks.
   2. Locking mechanical joints.
   3. Set-screw mechanical retainer glands.
   4. Bolted flanged joints.
   5. Heat-fused joints.
   6. Pipe clamps and tie rods.

B. Concrete thrust blocks required for all joints on fire-service main piping.

C. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
   1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
   2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
   3. Fire-Service-Main Piping: According to NFPA 24.

D. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

3.8 WATER METER INSTALLATION

A. Water meter to be installed by EWEB.

3.9 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and EWEB.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick, concrete piers, or pipe supports.

3.10 WATER METER BOX INSTALLATION

A. Water meter box to be installed by EWEB.

3.11 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C 891 and manufacturer's recommendations. Provide sump pump that daylights to curb, power for sump pump, and high water alarm to vault.

3.12 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. AWWA Fire Hydrants: Comply with AWWA M17.

3.13 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install protective pipe bollards on two sides of each fire department connection if it is within 5' of a vehicular way.

3.14 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water-distribution piping to utility water main or existing water main. Use tapping sleeve and tapping valve or service clamp and corporation valve.

C. Connect water-distribution piping to interior domestic water and fire-suppression piping.

D. Connect waste piping from concrete vault drains to sanitary sewerage system. See Section 33 31 11 "Sanitary Utility Sewerage Piping" for connection to sanitary-sewer or storm-drainage system. See Section 33 41 00 "Storm Utility Drainage Piping" for connection to storm-sewer piping.

3.15 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
   1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.16 CLEANING

A. Clean and disinfect water-distribution piping as follows:
   1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
   2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
   3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
      a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
      b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
      c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
      d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION

SECTION 33 31 00
SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
   1. Pipe and fittings.
   2. Nonpressure and pressure couplings.
   3. Cleanouts.
   4. Manholes.

1.2 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Cleanouts
   2. Pipe material.
   3. Mechanical plugs.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Field quality-control reports.

1.4 PROJECT CONDITIONS

A. Site information: Research public utility records and verify existing utility locations prior to ordering any materials. Notify the Architect immediately if any discrepancies are found in the project survey.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 “Piping Applications” Article for applications of pipe, fitting, and joining materials.

2.3 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A 746, for push-on joints.

B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.

C. Compact fittings: AWWA C153, for push-on joints.

D. Gaskets: AWWA C11, rubber.

2.4 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:
   1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for solvent-cemented or gasketed joints.

2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

2.5 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.6 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:
1. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Expansion Joints:
1. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for expansion indicated.

C. Ductile-Iron Deflection Fittings:
1. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for up to 15 degrees of deflection.

2.7 CLEANOUTS

A. Cleanouts: At grade cleanouts shall have an adjustable sleeve-type housing, a threaded brass plug with counter sunk slot, and cast iron frame and cover.

2.8 MANHOLES

A. Standard Precast Concrete Manholes:
1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints rubber gasketed joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation if site conditions warrant and/or as shown in plans.
4. Base Section: 6-inch minimum thickness for floor slab and 5 inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 5-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Gaskets: ASTM C 443 (ASTM C443M), rubber or preformed plastic.
8. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
9. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
10. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP; wide enough to allow worker to

place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.

11. Adjusting Rings: Interlocking rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
12. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:
1. Description: Ferrous; 23-inch ID by 3- to 7-inch riser, with 3 ¼ -inch- minimum-width flange and 24 ¾-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A 536, Grade 60-40-18 ductile or ASTM A 48/A 48M, Class 35 gray iron designed for heavy duty service unless otherwise indicated.

2.9 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:
1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 3000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
a. Invert Slope: Uniform slope through manhole to match invert elevations per plans, minimum 2 percent.
2. Benches: Concrete, sloped to drain into channel.
a. Slope: 8 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.2 PIPING APPLICATIONS

A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
a. Unshielded or Shielded flexible couplings for same or minor difference OD pipes.
b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.

c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

B. Gravity-flow, Nonpressure Sewer Piping: Use any of the following pipe materials for each size range.
1. NPS 4 to NPS 15: PVC sewer pipe and fittings gaskets, and gasketed joints.

3.3 PIPING INSTALLATION

A. Install tracer wire directly over piping and at outside edges of underground structures. See Section 31 20 00 "Earth Moving" for tracer wire material requirements.

B. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

D. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

E. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

F. Install gravity-flow, nonpressure, sewer piping according to the following:
1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
2. Install piping with 36-inch minimum cover.
3. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

H. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

I. Install backwater valves in piping where indicated.

3.4 PIPE JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Section 33 05 00 "Common Work Results for Utilities." Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

B. Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
2. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.
3. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.

C. Pipe couplings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
a. Unshielded flexible couplings for pipes of same or slightly different OD.
b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.5 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface for manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.7 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use pipe fittings in sewer pipes at branches for cleanouts, and use PVC pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot- areas.
   2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
   3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
   4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, per the Detail. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.8 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drain. Use transition fitting to join dissimilar piping materials.

B. Connect force-main piping to building's sanitary force mains specified in Section 221316 "Sanitary Waste and Vent Piping." Terminate piping where indicated.

C. Make connections to existing public sewer mains and manholes per the requirements of the City of Eugene.

D. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by core drilling into existing unit. Make connection into existing pipe using an “Inserta-Tee” fitting per the manufacturer’s recommendations or approved equal. Make connection to existing manhole using round rubber gasket installed on the pipe per the manufacturer’s instructions. Cut end of connection pipe passing through the manhole wall to conform to the shape of and be flush with the inside wall unless otherwise indicated. The opening around the gasket shall be grouted to a watertight seal. Existing manhole inverts, flow lines, channels, etc. shall be chipped out and re-grouted to accommodate the new pipe.
      a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
      b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

E. Connect to grease, oil, and sand interceptors.

F. Make connections to existing piping and underground structures so finished Work complies with requirements specified for new Work.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
   1. Submit separate report for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Test completed piping systems according to requirements of authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   4. Submit separate report for each test.
   5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
      a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
      b. Allowable leakage is maximum of 50 gal. /inch of nominal pipe size per mile of pipe, during 24-hour period.
      c. Close openings in system and fill with water.
      d. Purge air and refill with water.
      e. Disconnect water supply.
      f. Test and inspect joints for leaks.
      g. Option: Test concrete gravity sewer piping according to ASTM C 924.
   6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
      a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
   7. Manholes: Perform hydraulic test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION

SECTION 33 41 00
STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes gravity-flow nonpressure storm drainage outside the building, with the following components:
   1. Pipe and fittings.
   2. Trench Drains.
   3. Manholes.
   4. Cleanouts.
   5. Nonpressure transition couplings.
   6. Catch basins.
   7. Stormwater inlets.
   8. Overflow inlets.
   9. Water quality manhole.
   10. Pipe outlets.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Cleanouts.
   2. Inlets.
   3. Pipe.
   4. Fittings.
   5. Drains.
   6. Trench Drains.

B. Shop Drawings:
   1. Precast Concrete Manholes & Water Quality Manholes: Include plans, elevations, sections, details, frames, and covers.
   2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.
   3. Cast-in-place concrete manholes, including frames and covers.
   4. Pre-cast concrete structures, including frames and covers.

C. Field quality-control reports.

1.3 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Architect no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of service without Architect's written permission.

B. Site Information: Research public utility records, and verify existing utility locations prior to ordering any materials. Notify Architect immediately if any discrepancies are found in the project Survey.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A 746, for push-on joints.

B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153, for push-on joints.

D. Gaskets: AWWA C111, rubber.

2.2 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
   1. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
   1. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.3 PVC PIPE AND FITTINGS

A. PVC Corrugated Sewer Piping:
   1. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
   3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35 with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

C. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T- 1 or 2 wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.4 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Concrete Pipes: ASTM C 443, rubber.
   2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
   1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:
   1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:
   1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.5 CLEANOUTS

A. Cast-Iron Cleanouts:
   1. Description: Cleanouts: At grade cleanouts shall have an adjustable sleeve-type housing, a threaded brass plug with counter sunk slot, and cast iron frame and cover.
   2. Top-Loading Classification(s): Light Duty, Medium Duty, Heavy Duty, and Extra-Heavy Duty.
   3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.6 MANHOLES

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Diameter: 48 inches minimum unless otherwise indicated.
   3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation, if site conditions warrant and/or as shown in the plans.

4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
8. Steps: Individual FRP steps, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals.
9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:
1. Description: Ferrous; 23-inch ID by 6- to 10-inch riser with 3.5-inch- minimum width flange and 25-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A 536, Grade 60-40-18 ductile or ASTM A 48/A 48M, Class 30 gray iron unless otherwise indicated.

2.7 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:
1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
a. Invert Slope: 1 percent through manhole.
2. Benches: Concrete, sloped to drain into channel.
a. Slope: 4 percent.

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.8 POLYMER-CONCRETE TRENCH DRAINS

A. General Requirements for Polymer-Concrete, Channel Drainage Systems: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include quantity of units required to form total lengths indicated.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ACO USA.
2. Poly-Cast.
3. Zurn.
4. Approved equal.

C. Polymer-Concrete Systems:
   1. Channel Sections:
      a. Interlocking-joint, precast, modular units with end caps.
      b. 4-inch inside width and deep, rounded bottom, and with outlets in quantities, sizes, and locations indicated.
      c. Extension sections necessary for required depth.
      d. Frame: Include ductile iron or steel frame for grate.
   2. Grates:
      a. Jamison Cast Ductile Iron by Urban Accessories.
   3. Covers: Solid gray iron if indicated.
   4. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
   5. Invert: Per Plan.

D. Drainage Specialties: Precast, polymer-concrete units.
   1. In-line Catch Basins:
      a. 24-inch deep polymer-concrete body, with outlets in quantities and sizes indicated.
      b. ADA iron.
      c. Grate load class: C.

E. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

F. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.9 CATCH BASINS, AREA DRAINS, AND DECK DRAINS

A. Trapped Catch Basins:
   1. 1/4-inch or 10-gage steel plate bituminous coated as manufactured by Lynch, Gratemaster, Gibson Steel Basins, or approved equivalent. Reinforced concrete collars shall be installed per the Drawings.
   2. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for heavy-duty service H-20, structural loading. Include flat grate with small square or short-slotted drainage openings.
      a. Size: To match basin, 28 by 28 inches minimum unless otherwise indicated.
      b. Grate Free Area: Approximately 50 percent unless otherwise indicated.

B. Deck Drain:
   1. 1/4-inch or 10-gage steel plate bituminous coated as manufactured by Lynch, Gratemaster, Gibson Steel Basins, or approved equivalent. Reinforced concrete collars shall be installed per the Drawings.
   2. Grates: OPCB Cast Ductile Iron by Urban Accessories. Size to be 15 by 15 inches to match frame size. Confirm size with basin manufacturer.

C. Area Drain:
   1. Nyloplast Drain Basin or approved equivalent. Reinforced concrete collars shall be installed per the drawings. Grate per drawings.

2.10 WATER QUALITY MANHOLE

A. Contech CDS model CDS2015-F-C, per Drawings.

2.11 PIPE OUTLETS

A. Concrete Pipe Outfall: as shown on Drawings.

2.12 OVERFLOW INLETS

A. Ditch Inlets: By Gibson Steel Basins or approved equivalent. Made with face opening to match side slopes of materials and dimensions as shown on the Drawings.

B. Overflow Inlets: Round inlet by Gibson Steel Basins or approved equivalent with a ductile iron beehive grate. All materials and dimensions as shown on the Drawings.

PART 3 - EXECUTION

3.1 EARTHWORK

1. Excavation, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving." Install tracer wire directly over piping and at outside edges of underground structures. See section 31 20 00 “Earth Moving” for tracer wire material requirements.

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process or microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow at a minimum slope of 1 percent, unless otherwise indicated.
   2. Install piping with 36-inch minimum cover, unless otherwise indicated.
   3. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
   4. Install PE corrugated sewer piping according to ASTM D 2321.
   5. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
   6. Install piping below frost line.

G. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
   1. Ductile-iron pipe and fittings.

H. Clear interior of piping and manholes of dirt and superfluous material as work progresses.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
   2. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
   3. Join PVC corrugated sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints.
   4. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
   5. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
   6. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC fittings in sewer pipes at branches for cleanouts and PVC pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
   2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
   3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
   4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, as indicated on plans. Set with tops 1 inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated.

3.7 WATER QUALITY MANHOLE INSTALLATION

A. Per the manufacturer’s recommendations.

3.8 STORMWATER OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap as indicated.

3.9 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.10 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 22 14 13 "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
      a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
      b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Pipe couplings and expansion joints with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
    a. Unshielded or Shielded flexible couplings for same or minor difference OD pipes.
    b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
    c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.11 IDENTIFICATION

A. Install green tracer wire directly over piping and at outside edges of underground structure. See Section 31 20 00 “Earth Moving” for tracer wire material requirements.

3.12 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
    1. Submit separate reports for each system inspection.
    2. Defects requiring correction include the following:
        a. Alignment: Less than full diameter of inside of pipe is visible between structures.
        b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
        c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
        d. Infiltration: Water leakage into piping.
        e. Exfiltration: Water leakage from or around piping.
    3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
    4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
    1. Do not enclose, cover, or put into service before inspection and approval.
    2. Test completed piping systems according to requirements of authorities having jurisdiction.
    3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
    4. Submit separate report for each test.
    5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
        a. Option: Test plastic piping according to ASTM F 1417.
        b. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION

SECTION 33 46 00
SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes subdrainage systems for retaining walls, foundations, footings, and stormwater infiltration facilities:
   1. Perforated-wall pipe and fittings.
   2. Geotextile filter fabrics.
   3. Backwater valves.

1.2 SUBMITTALS

A. Product Data:
   1. For geotextile filter fabrics.
   2. Perforated pipe.
   3. Solid-wall pipe.
   4. Multi-Flow drainage system
   5. Backwater valves.

B. Inspection report.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated schedule 40 PVC Sewer Pipe and Fittings: ASTM D 1785, D2665 or F891, solvent welded joints.

2.2 MULTI-FLOW DRAINAGE SYSTEM

A. Perforated geo-composite, prefabricated, stormwater collection system by Multi-Flow and associated fittings by Multi-Flow.

2.3 SOLID-WALL PIPES AND FITTINGS

A. Refer to specification section 33 41 00 “Storm Utility Drainage Piping.”

2.4 SPECIAL PIPE COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of the same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.

2.5 CLEANOUTS

A. Cast-Iron Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing; and secured, scoriated, Medium-Duty Loading class, cast-iron cover. Include cast-iron ferrule and countersunk, brass cleanout plug.

B. PVC Cleanouts: ASTM D 3034, PVC cleanout threaded plug and threaded pipe hub.

2.6 SOIL MATERIALS

A. Backfill, drainage course, and satisfactory soil materials are specified in Division 31 Section 31 20 00 "Earth Moving."

B. Sand per manufacturer’s specifications for Multi-flow drainage system.

2.7 GEOTEXTILE FILTER FABRICS

A. Use “Drainage Fabric” as found in 31 20 00 “Earth Moving.”

B. Structure Type: Nonwoven, needle-punched continuous filament.
   1. Style(s): Flat and sock.

2.8 BACKWATER VALVES

A. PVC Backwater Valve: PVC Body with extendable riser pipe.
   1. Available Manufacturers:

a. Clean Check.
b. Rector Seal.
c. Mainline.
d. Approved equal

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section 31 20 00 "Earth Moving."

3.2 PIPING APPLICATIONS

A. Underground Perimeter Foundation and Wall Piping:
   1. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

B. Header Piping:
   1. PVC sewer pipe and fittings, couplings and coupled joints.

C. Stormwater Facility:
   1. Perforated PVC Sewer Pipe and fittings, and loose, bell-and-spigot joints.

3.3 CLEANOUT APPLICATIONS

A. In Underground Subdrainage Piping:
   1. At Grade in Earth: PVC Cleanouts.
   2. At Grade in Paved Areas: PVC cleanouts.

3.4 FOUNDATION DRAINAGE INSTALLATION

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides so that fabric overlaps itself at least 12 inches at top.

B. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.

C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

D. Add drainage course to width of at least 9 inches on side away from wall and to top of pipe to perform tests. Refer to Part 3 “Field Quality Control.”

E. After satisfactory testing, cover drainage piping to width of at least 9 inches on side away from footing and above top of pipe to within 6 inches of finish grade.

F. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

G. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.5 MULTI-FLOW DRAINAGE SYSTEM INSTALLATION

A. Per manufacturer’s recommendations and Drawings.

3.6 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
   1. Perimeter Foundation Subdrainage: Install piping at elevations shown on drawings.
   2. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of 36 unless otherwise indicated.
   3. Stormwater Facilities: Install Piping level.
   4. Lay perforated pipe with perforations down.
   5. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install PVC piping according to ASTM D 2321.

3.7 PIPE JOINT CONSTRUCTION

A. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.

B. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.

C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.8 BACKWATER VALVE INSTALLATION

A. Comply with requirements for backwater valves specified in Section 33 41 00 "Storm Utility Drainage Piping."

B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.

C. Install horizontal backwater valves where indicated.

3.9 CLEANOUT INSTALLATION

A. Comply with requirements for cleanouts specified in Section 33 41 00 "Storm Utility Drainage Piping."

B. Cleanouts for Foundation and Retaining-Wall Subdrainage:
   1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
   2. In vehicular-traffic areas, use NPS 4 PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, as shown on Drawings. Set top of cleanout flush with grade.
   3. In non-vehicular-traffic areas, use NPS 4 PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, as shown on Drawings. Set top of cleanout 1 inch above grade.

3.10 CONNECTIONS

A. Connect low elevations of subdrainage system to site’s solid-wall-piping storm drainage system.

3.11 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
   2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.12 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION